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INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(LISBON, 1949.)

QUESTION I.

a) **Mechanisation of the maintenance and renewal of the permanent way.**

b) **Recent improvements relating to reinforced concrete and prestressed concrete sleepers. Results obtained.**

c) **Recovery and strengthening of metal bridges that have reached the theoretical limit of safety.**

a) Mechanisation of the maintenance and renewal of the permanent way.

REPORT

(Belgium and Colony, Bulgaria, Denmark, Spain, Finland, France and Colonies, Greece, Hungary, Italy, Luxemburg, Norway, Netherlands and Colonies, Poland, Portugal and Colonies, Rumania, Sweden, Switzerland, Czechoslovakia, Turkey and Jugoslavia),

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Introduction.

The question has been divided into two parts :—

I. *Mechanisation of the maintenance of the permanent way.*

II. *Mechanisation of the renewal of the permanent way.*

I. Mechanisation of the maintenance of the permanent way.

Before considering what has been done in the way of mechanisation, the evolution of the methods used will be briefly considered.

From the first beginnings of the rail-

ways the maintenance of the permanent way was in the hands of small gangs which were responsible for the following work :—

Maintain track, drainage, signal transmission, etc., by the « stitch in time » method.

Fig. 1. — « Robel » ratchet spanner.

Arrange for the necessary staff to cover the essential day-to-day inspections.

Protect level crossings and certain signalling posts by using gangers' wives.

Lengthening the period between inspections, the use of bicycles, sometimes facilitated by the provision of paths, the use of trolleys or lorries, the installation of colour light signals, which are maintained by special staff, have helped in extending the length of the section.

The maintenance of the permanent way by the « stitch in time » method has been replaced by the « general overhaul », consisting in restoring at a determined rate all parts of the track. The method has been perfected notably in France by dividing it into the « complete overhaul », under which a part of the line, generally $\frac{1}{4}$ of the length supervised, is restored to as satisfactory a state as possible, and the « partial overhaul », carried out as required and principally consisting of tightening the fastenings without replacements (except where essential), the re-levelling in

whole or part, and the lining up. Details not covered under these headings are simply inspected to make sure the fastenings are tight.

In order to obtain a reasonable output of work, the gangs have to be large enough and this has also extended the length of the section.

For a number of years the railways have studied production methods and applied them to the permanent way gangs, whether provided with mechanical appliances or not. In this way the output has been increased and the staff reduced, but as the staff cannot be reduced below a certain minimum and a reasonable output still obtained, this has also led to the lengthening of sections.

To sum up, the evolution has been on the lines of larger gangs, increasing section lengths and co-ordinating and following up the work done, thereby making supervision easier and preventing neglect persisting over long periods.

The full use is not made of mechanical appliances in the hands of small gangs : there is also a risk of their being poorly maintained. Mechanisation, when even partial, also leads to the extension of the « lengths ».

Now let us consider the replies to the questionnaire. Appliances will be described briefly : complete details can be obtained from the makers or users.

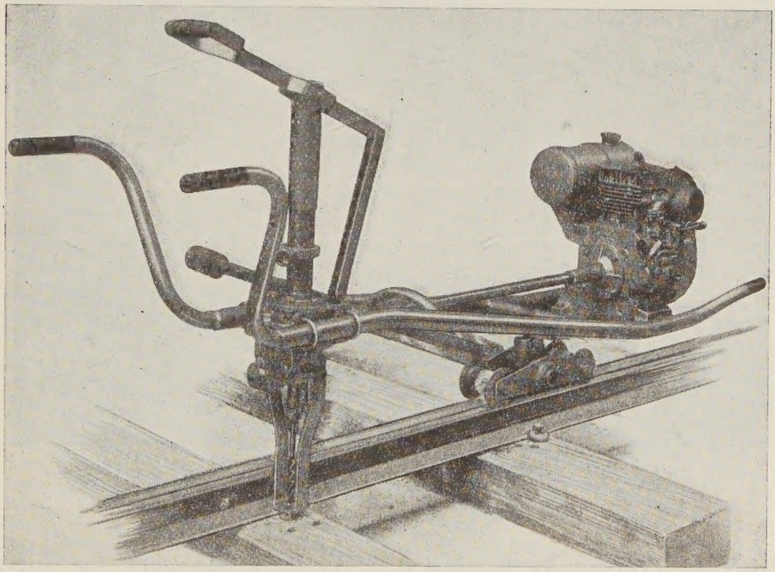


Fig. 2. — « Jami » drill.

QUESTION I. — *Do you use power tools or improved spanners for undoing and tightening fish plate bolts?*

The Belgian, Swiss and Luxemburg Railways use the « Robel » ratchet spanner (fig. 1). The other railways use ordinary spanners.

There appears to be some advantage in dividing the movements by using two spanners :—

— a long handled spanner to start the undoing of the nuts or for tightening them up,

— a light short-handled spanner for intermediate undoing and tightening the nuts.

As the operation is so simple, there appears to be no case for mechanising this job.

— Stud auger for cleaning out the holes in which spikes will be inserted (fig. 4).
— Cylindrical auger (fig. 5).
— Auger for opening out the top of the hole (fig. 6).

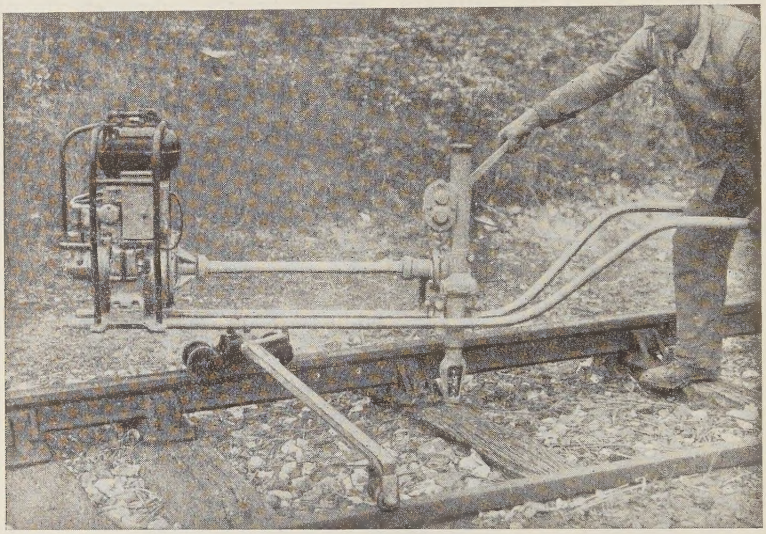


Fig. 3. — « Collet » drill with « Briban » motor.

QUESTION II. — *Do you use machines for drilling the wood screw holes in sleepers?*

The various types of drilling machine normally used in a workshop will not be considered, but only those used out on the track. The machines best adapted to the job appear to be those with individual motors as they can be lifted clear of the track easily (see Question XVII).

The « Jami » (fig. 2) and the « Collet » (fig. 3) drills are driven by 2 to $2\frac{1}{2}$ H.P. motors. The drill runs at 1 500 to 2 500 r.p.m.

Much work was needed before the drills were satisfactory. Three types of drill are used in France :

As it is necessary for augers to be changed quickly, the « Graffenstaden » spigoted augers, which are satisfactory in this respect, were adopted.

The output of these machines is :

— 400 holes per hour for cleaning out the wood screw hole to take the spike.
— 200 holes per hour when drilling the spikes.

The use of these tools in day-to-day maintenance is only profitable when there are at least 50 holes to drill per hectometre. If fewer, ordinary tools suffice. The wide use of the centre bit (fig. 7), in France should be noted.

QUESTION III. — *Do you use tools or improved spanners for tightening up wood screws or for driving spikes?*

The most widely used machines are :

— « Collet » individual motor or electric

— « Pouget » individual motor driven wood screw driver (fig. 10).

These tools are fitted with 4 to 6 H.P. motors. The speed varies between 90 and 200 r.p.m. It would appear that the most usual speed is 100 r.p.m.

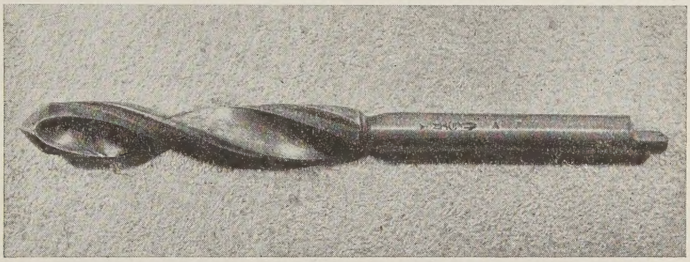


Fig. 4. — Stud auger.

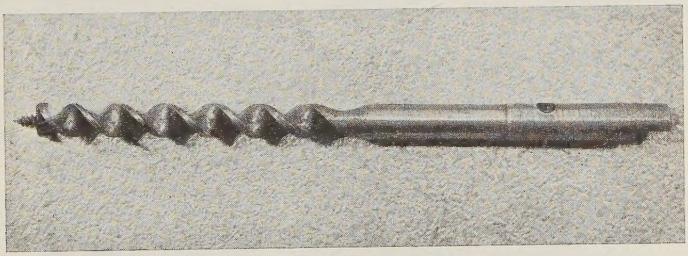


Fig. 5. — Cylindrical auger.

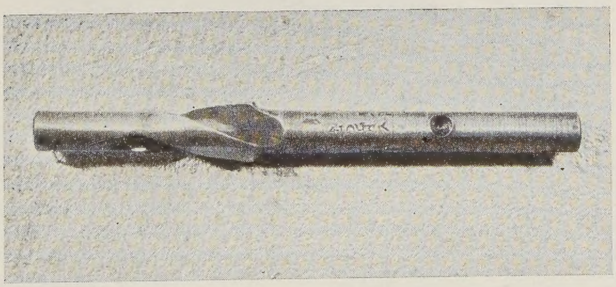


Fig. 6. — Borer.

motor driven wood screw drivers (fig. 8).

— « Jami » individual motor driven wood screw driver (fig. 9).

Great care must be taken to set the clutch correctly, as otherwise the wood screws will be insufficiently tightened or overtightened and the wood torn.

The output of the machines varies with the work to be done and the condition of the sleepers :

— When driving or withdrawing wood screws in old holes : 425 wood screws per hour.

— When driving wood screws in spikes: 370 per hour.

In France and on the Algerian lines the « Lompret Guille » hand-operated wood screw driver (fig. 11) is used. Wood screws of some 250 m. of track can be tightened per day by two men.

The use of mechanical wood screw drivers in day-to-day maintenance is likely to give the best results on old track where a large number of wood screws have to be replaced or re-spiked.

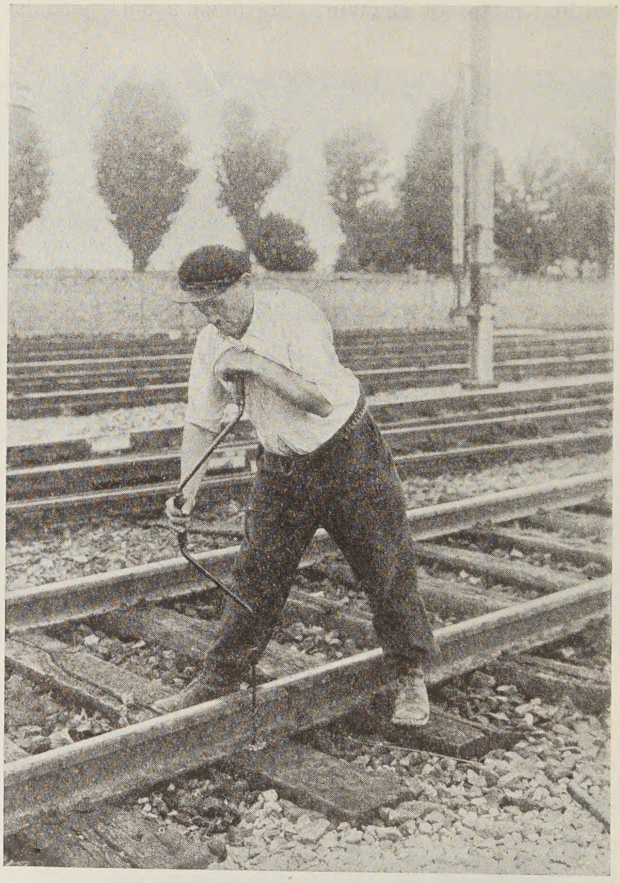


Fig. 7. — Centre bit.

QUESTION IV. — *Do you use machines out on the lines :*

(a) *to recut the seats in the sleepers of flat bottom rails without bed-plates?*

(b) *to re-adze sleepers on double-headed track?*

Switzerland, Belgium and Denmark report tests of the « Collet-Cantin » cutting machine.

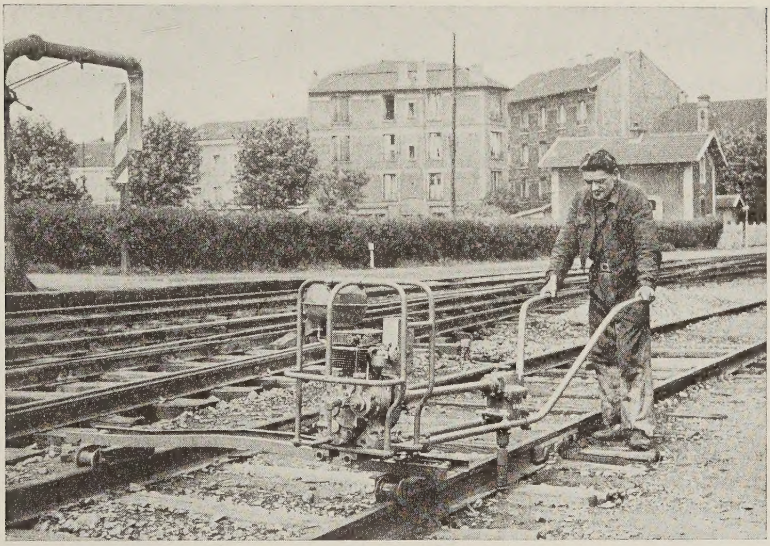


Fig. 8. — « Collet » wood screw driver with « Briban » motor.

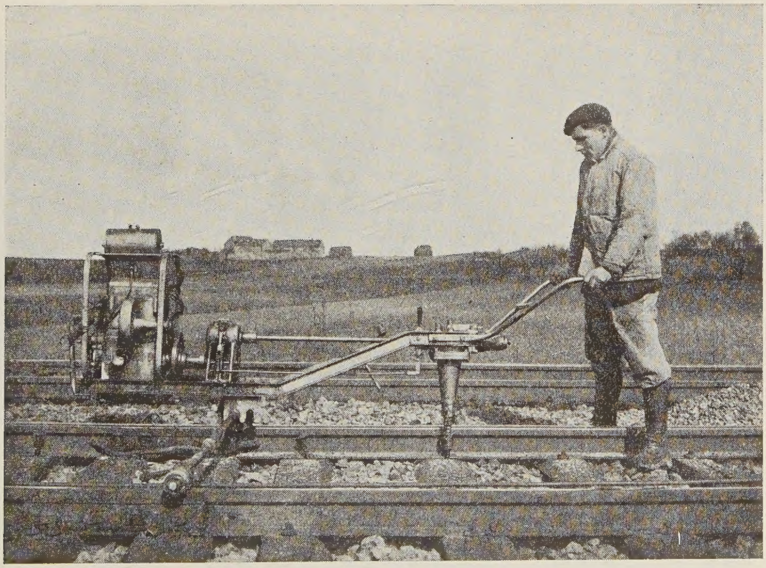


Fig. 9. — « Jami » wood screw driver, with « Jap » motor.

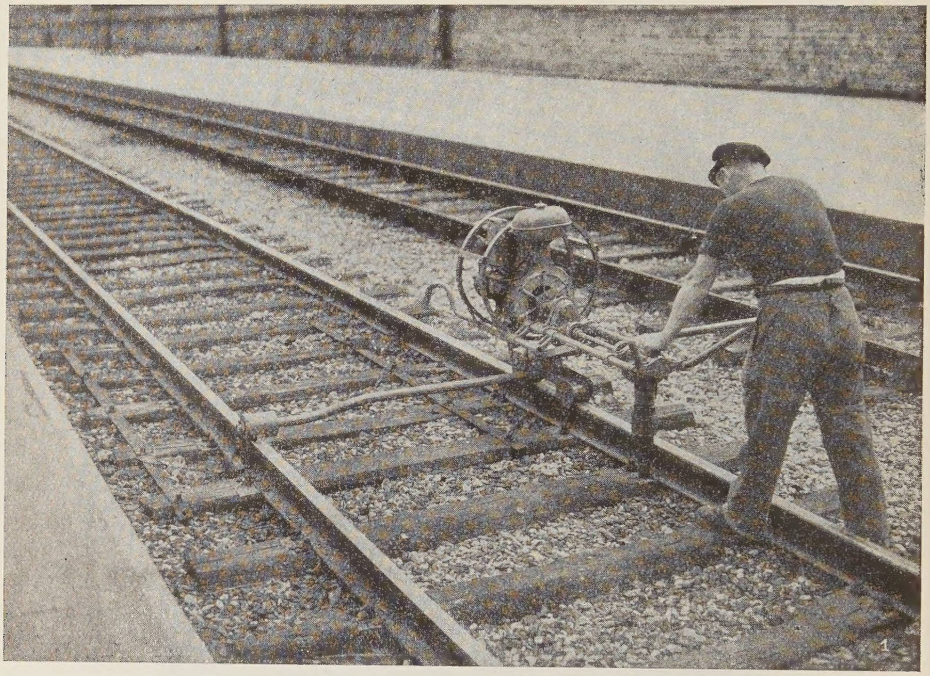


Fig. 10. — « Pouget » wood screw driver with « Briban » motor.

Fig. 11. — « Lompret-Guille » hand operated wood screw driver.

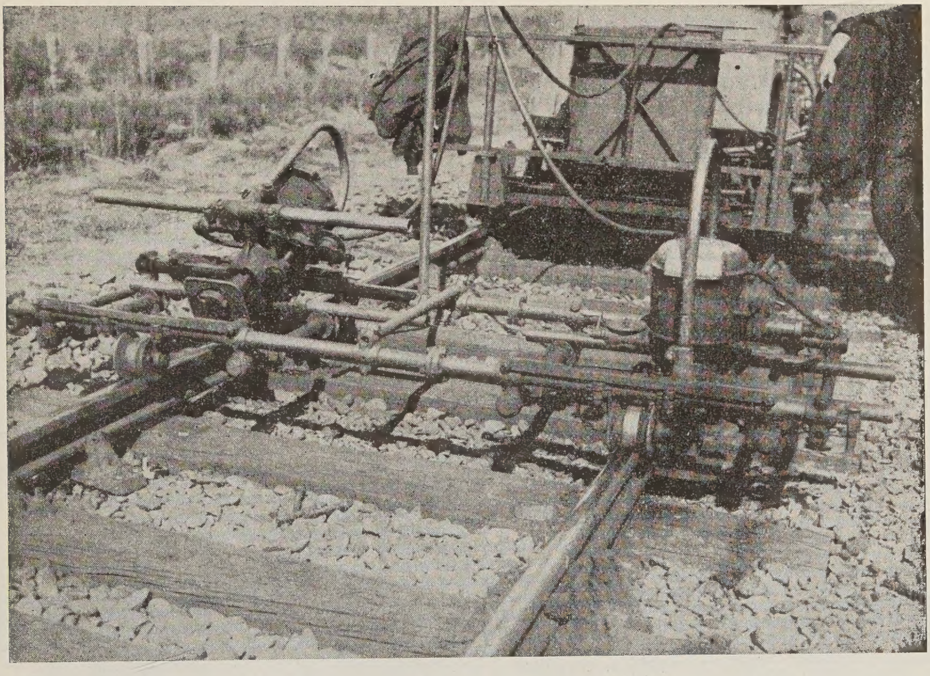


Fig. 12. — « Collet » electric grooving tool.

Fig. 13. — « Collet-Cantin » electric cutting machine.

The following machines are used in France :

— The « Collet » electric grooving tool (fig. 12), used for :
 — cleaning up the adzing on double-headed rail track,

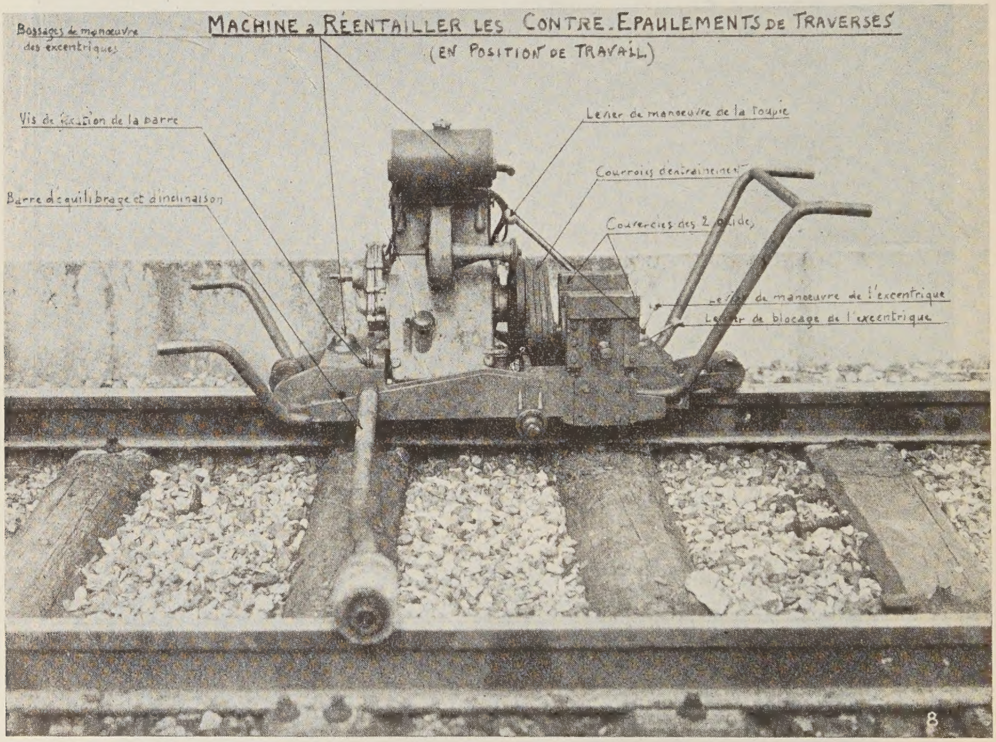


Fig. 14. — « Pouget » cutting machine.

 — flat bottom rail track laid without bed-plates to renew the grooves — output about 100 sleepers per hour.

— The « Collet-Cantin » cutting machine (fig. 13) driven electrically by 2 H.P. petrol motor.

— The « Pouget » cutting machine (fig. 14) driven by an individual motor of 3 to 6 H.P., according to type.

The cutting machines will do up to 200 to 250 shoulders an hour. The life of the blades or cutters has been improved by using Molybdenum carbide tips.

The tendency in France is to drive such machines by individual motors as this, by avoiding the use of generators and consequent cables, makes them more easily handled.

QUESTION V. — *Do you use special tools for driving in spikes?*

Denmark and Holland report the use of a special tool but have not supplied any details.

In France a tool called a « bouche

bouteille » is used frequently. This tool is clipped to the rail in line with the hole into which the spike is to be driven and is locked by a pedal on which the workman applies pressure with his foot (fig. 15).

A weight striking a mandril drives the spike into the hole.

With this tool the spike is driven home without being damaged, the work is less fatiguing than it was when done with a short-handled sledge-hammer.

The output is some 50 spikes per man hour.

Too much force should not be used in order not to split the sleepers.

QUESTION VI. — *Do you use special equipment to restore the track to gauge?*

The S.N.C.F. uses, in the case of certain gangs employed on repairs, a machine combined with a drill or wood screw driver for rapidly and accurately correcting the gauge of double-headed rail track (fig. 16).

The machine is controlled by a pulley which, acting on the rails, sets them to the desired gauge. A finger on a graduated disc indicates to the operator the distance between the rails. When correct, the sleepers are drilled and the wood screws driven mechanically by tools attached to the machine.

Fig. 15. — Special tool for driving in spikes (bouche-bouteille).

QUESTION VII. — *Do you use any special methods for replacing defective sleepers when found?*

As the replacement of sleepers found defective affects the stability of the track for a more or less long period, the French Permanent Way Services have endeavoured to find a method whereby this period of instability is reduced to a minimum.

Several of the S.N.C.F. regions have adopted, with this object in view, the method known as « gravelling » the

sleepers, for which a special tool, called a graveller (fig. 17) is used, both with double-headed rail and flat bottom rail track sleepers.

The principle of this method, which is under test at the present time in Belgium, is as follows :

Having noted the difference in thickness of the sleeper to be withdrawn and that to be substituted, (a difference which can be nil, plus or even minus), the upper bearing area is built up in such a manner that the replace sleepers will acquire, after a certain number of trains have run over them, practically the same stability as that of the adjacent sleepers.

The time required to replace a sleeper in this manner is about an hour.

The height between the underside of the rail and the top of the mould is given by the apparatus which is fitted with a slide adjustable to the thickness of the sleeper. The method can only be used on lines maintained by shovel packing.

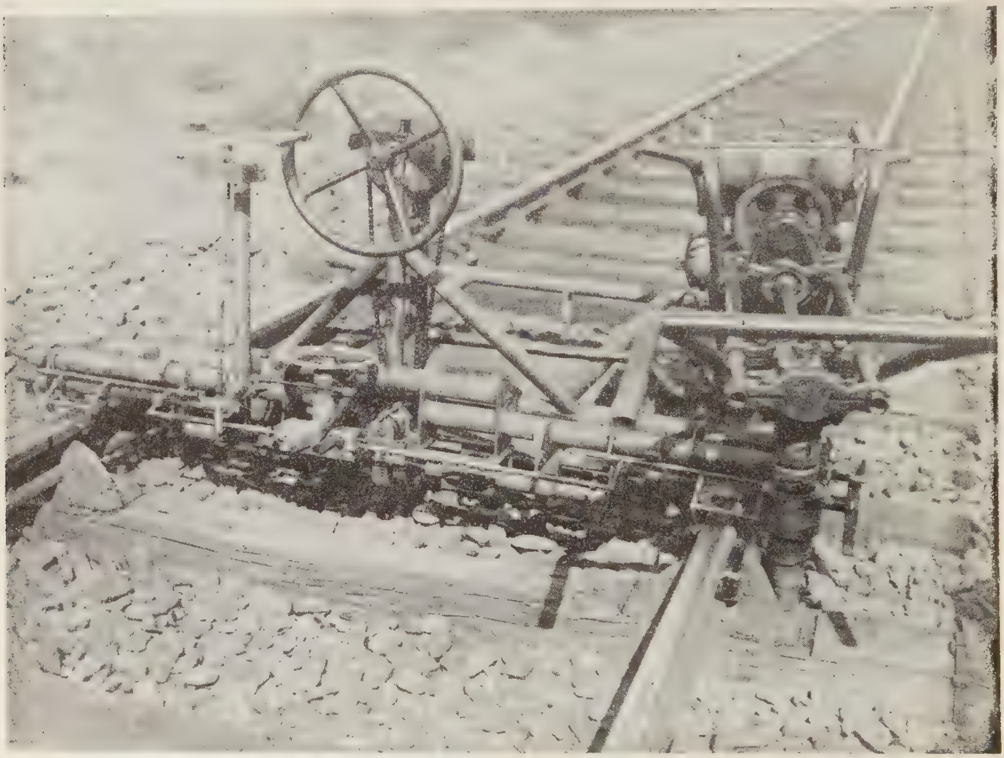


Fig. 16. — Machine to restore the track to gauge. General view.

QUESTION VIII. — *During day-to-day maintenance do you carry out the levelling of the permanent way by mechanical appliances, such as tampers, for example?*

Denmark uses « Ingersoll-Rand » tampers and is proposing to also use « Matisa » tampers.

In Holland, « Robel », « Pegson » and « Matisa » tampers are used.

In Switzerland the track levelling is carried out by hand or by using the « Matisa » tamper. The « Matisa » and « Jackson » (American) machines are used as well.

Poland has two « Matisa » machines under test.

Spain also is using two « Matisa » machines.

Fig. 17. — Graveller.

The Algerian railways have used in ordinary maintenance « Drouard », « Collet » and « Matisa » tampers, but suggest that these tools do not give satisfactory results unless the track has to be lifted about 5 cm. (2″). They report that tests are in hand with the American tamper, « Barro », (independent tampers with internal combustion motors), but have not sent a description of these tools.

In France, measured shovel packing is, practically speaking, the only method used for track levelling in day-to-day maintenance.

In special cases, tamping is used when the line has to be raised considerably (restoration of a line quickly, super-elevating a curve after correction, low or wet spots having to be lifted).

The shovel packing first used by the English railways was introduced into France in 1910 by the Nord. It was then carried out by successive approximation. The method was perfected in 1928 in the form of measured shovel packing by M. LEMAIRE, then Engineer of the Nord and now the General Manager of the S.N.C.F.

Measured shovel packing consists in measuring by accurate instruments, the visible defects in the track level (view finder and levelling staff) or hidden dansometer, and to add to the bearing seat of the sleeper known as the mould, the quantity of fine ballast needed to give the necessary correction. The fine

Fig. 18. — Measured shovel packing.

Fig. 19. — View finder and levelling staff.

ballast is added by means of a packing shovel and a measuring shovel (fig. 18).

QUESTION IX. — *Do you use special methods for accurate levelling of the track?*

Holland and Belgium (the latter as a trial) use an articulated lever specially designed for the purpose. The accurate packing shovel, this latter having a vertical register line (fig. 19) on the back face.

Some railways set track fittings and even the alignment of the track from the centre line thereof by means of a special instrument. This method has the advantage of dividing gauge irregularities between the two lines of track.

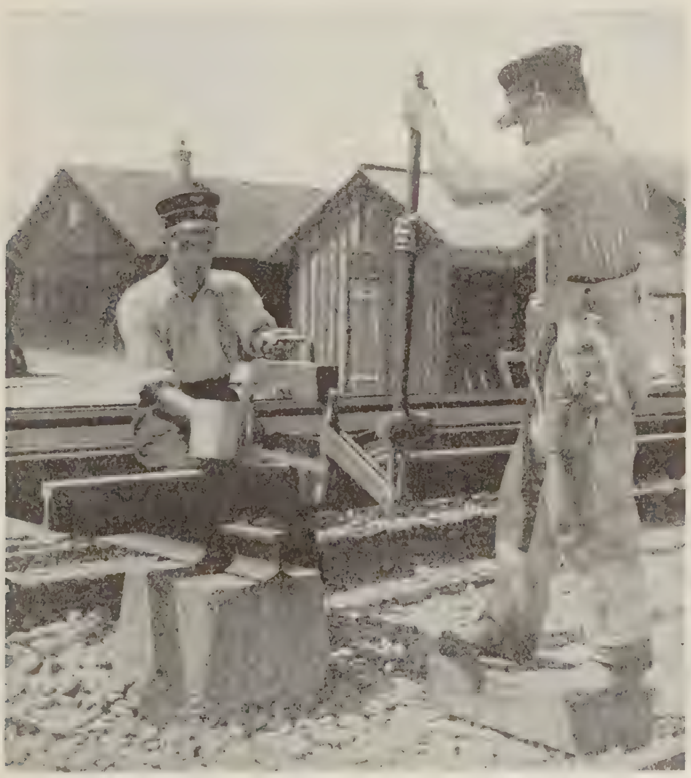


Fig. 20. — « Robel » articulated hand saw.

levelling of tracks run over at speed adds greatly to the passengers' comfort and lengthens the time the track remains in good order.

The accurate levelling of the alignment in France is maintained with the view finder and levelling staff of the

QUESTION X. — *What tools do you use to cut rails?*

All railways use, for the purpose of cutting rails :

— ordinary hand saws worked by 2 men,

— articulated hand saws (fig. 20),
— mechanical saws driven by a petrol engine (fig. 21).

This work rarely requires to be done in day-to-day maintenance.

QUESTION XI. — *What tools do you use for drilling rails?*

Most railways use, for the drilling of rails :

— hand ratchet drills,
— geared hand drills (fig. 22),
— mechanised drills driven by a petrol motor (fig. 23).

QUESTION XIII. — *What equipment do you use to clamp split sleepers?*

Do you do this in the shops as a preventive measure, or only out on the track when the sleepers have split?

Some railways fit « S » plates and bolts in the shops.

Clamping is undoubtedly most efficacious and lasting. It is being used more and more, both in the shops and on the track during maintenance work.

When clamping is done on the line the output is 2 or 3 clamps per man hour.

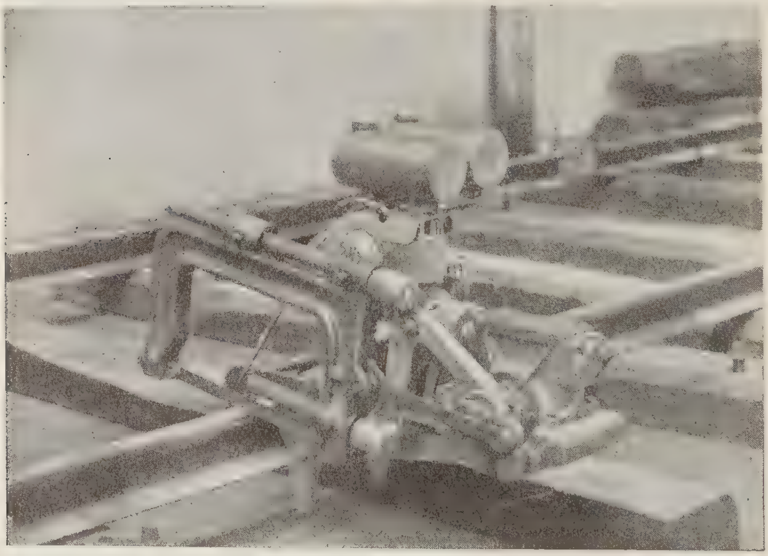


Fig. 21. — « Drouard » mechanical saw.

As it is unusual to have to drill rails in ordinary maintenance there is little advantage in mechanising the work.

QUESTION XII. — *What tools do you use for track slueing?*

Most railways use the « Robel » (fig. 24), « Schollaert » or « Le Rapide » tools, all on the same principle.

The tools most generally used are :
the « Delor » (fig. 25);
the « Royal » (fig. 26);
the « Gibert » (fig. 27).

QUESTION XIV. — *Do you use any special methods for cleaning the ballast between sleepers?*

The railways do not report any spe-

Fig. 22. — « Robel » geared hand drill.

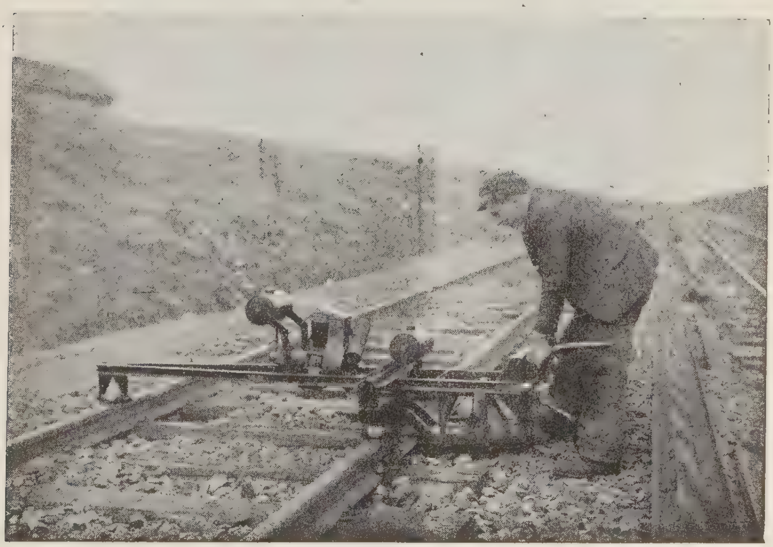


Fig. 23. — « Jami » mechanised drill.

cial method of cleaning ballast between sleepers.

The question does not arise on electrified lines, where the ballast remains clean. On steam lines with heavy steam traffic the ballast quickly becomes clogged, especially in countries where the quality of the coal is poor.

Cleaning ballast between sleepers is still done by hand and is expensive and raises a question of mechanisation which should be investigated. At the same time, the Locomotive Running Department ought to try to find means whereby ashes would be emptied at the depots only or at places specifically assigned to this purpose.

A further cause of pollution of the ballast is the leakage from wagons containing material such as coal, sand, etc. Here, too, there is something to be done.

QUESTION XV. — *Do you build up the ends of rails? If « yes », by what method? If possible, state how long each takes, and the cost.*

Switzerland and the Algerian railways build up the ends of rails by electric welding. Switzerland considers that if the work is done carefully the results are most satisfactory and has decided to continue to do this work. The Algerian railways, before building up the ends of the rails, cold strengthen the

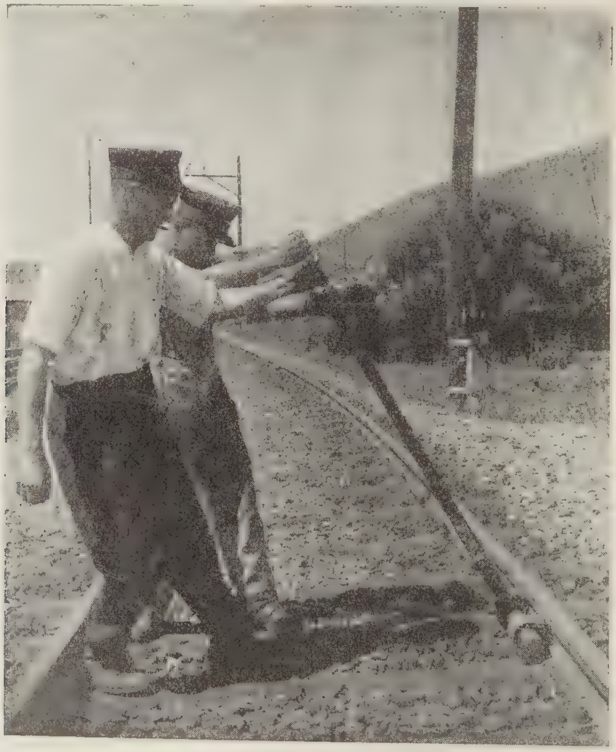


Fig. 24. — « Robel » slueing tool.

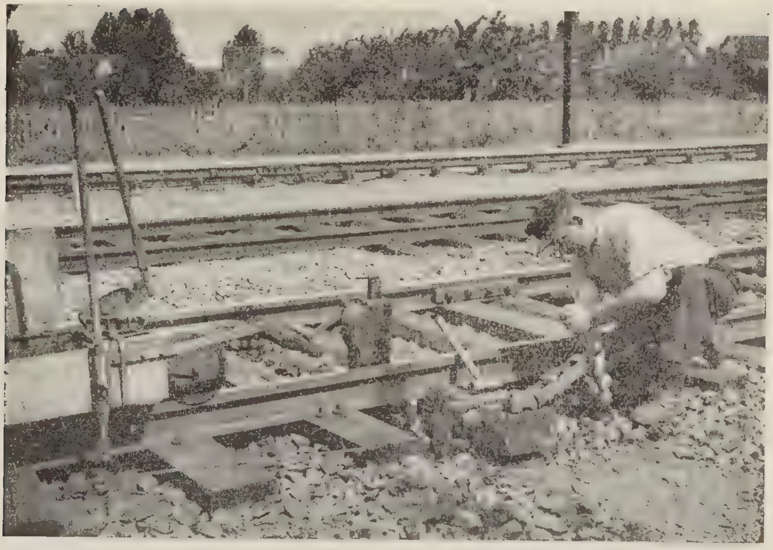


Fig. 25. — « Delor » clamping tool.

Fig. 26. — « Royal » clamping tool.

ends using « Schims » and re-stamp the fish plates. This system estimates the life of the built-up rail ends as 10 years under 20 ton axle loads.

In Denmark only the crossing points are built up with the « AGA » method, which has not been described.

Belgium and the Rhätische Bahn make use of arc welding, the first for track fittings, but only when repairing in the shops.

In France track fittings (points and crossings) are built up regularly. The tests of built-up rail ends continue.

carried on a trolley of the « Draisinenbahn » type. Four P.M. type lubricators fixed on the track are also under test.

On the Algerian railways the rails of curves or less than 300 m. (984′) radius are lubricated by hand with graphite. Automatic fixed lubricators are being fitted for experiment.

In Switzerland most of the electric locomotives have been fitted for some years with a lubricator by means of which both the tyre flanges and the rails are oiled. This system is entirely satisfactory. On the other hand, earlier tests

Fig. 27. — « Gibert » clamping tool.

QUESTION XVI. — *Do you lubricate rails on large radius curves? Are the oilers on the track or the locomotives?*

Most of the railways lubricate the rails on large radius curves.

In Norway, Sweden, Holland and Belgium, lubricators fixed on the track are used (P.M. type).

In Denmark the curves on the electrified lines in the Copenhagen suburbs are being lubricated with equipment

of fixed automatic lubricators of the P.M. type have been stopped.

The « Rhätische Bahn » lubricates the rails on curves with four « Bertschmann » lubricators carried on the outer axle of motor coaches. Lubrication can be either continuous or only on curves.

This railway reports that as the result of different tests this method has given the best results as regards upkeep and economy.

In France lubrication by lubricators

on the locomotives is being extended. Curves of R $\leqslant$ 500 m. (1 640′) are lubricated.

Seeing that the cost of installing a lubricator on a locomotive is only 2 to 3 times that of a fixed lubricator on the track, it would appear to be much more economical to let the locomotives lubricate the track. Fixed lubricators or hand lubrication appears to be preferable in the case of marshalling yards, ports, etc.

QUESTION XVII. — *What general comments have you to make as to the design and use of mechanised appliances?*

Generally speaking, the use of mechanised equipment for the maintenance of the permanent way is still in the experimental stage. Their introduction is too recent for information of value to be obtained.

The Swiss railways point out that the use of mechanised plant in maintenance work is of real value in view of the shortage of labour and its high cost. They add that the quality of the work done is more uniform than when done by hand under normal conditions.

Holland, too, considers that the introduction of mechanised plant in maintenance work is most attractive at the present time.

Belgium calls attention to the difficulty of synchronising successive operation with tools which do not work at the same rate.

The S.N.C.F. is still in the experimental stage. Experience obtained during the first tests was most favourable; the staff readily takes to the new working conditions and soon learns to handle the equipment. The investigations must therefore be followed up with care.

It is felt in France that as the various mechanised tools which can be placed at the disposition of gangs have different capacities, the work to be done not being uniform, a very intensive study of production methods should be completed for each individual case, as otherwise the men lose time and the machines are poorly used.

As regards design, we think that tools with individual motors and which can be removed from the running line easily, are to be preferred to those supplied with current from motor generator sets which are difficult to move along the lines or which are carried on lorries. It is easier to organise with independent tools, and repair depots are more flexible.

QUESTION XVIII. — *How have you organised the work of gangs having mechanised equipment? Can you give an example with full details as regards the allocation of staff, the appliances used and the results obtained?*

The organisation of the work of the maintenance gangs has been studied in France for some years.

This study is complicated for the following reason :

The work to be done varies widely, depending upon whether it relates to new track, a track of average age, or very worn track, which would be renewed if circumstances were more favourable.

In the first case, the organisation of the work is very simple and there is no need whatever for mechanised equipment. When dealing with more or less old track, each case has to be investigated separately and the staff and plant selected accordingly.

As in all other work, the first thing to do is to separate the operations which can be carried out independently. This is the division of the work.

It is then necessary to determine the operation times.

The number of operations to be car-

ried out must then be ascertained. The rate of speed of each operator has to be determined and the number of men at each depot so that the various operations, when interlocked, form a homogeneous whole, running at the same speed.

The results of the investigation should be shown in graphical form.

The upkeep of flat bottom rail track can be broken down into the following :—

1. Upkeep of joints, including, if necessary, recutting the shoulders of the joint pieces.

Fig. 28. — Upkeep of flat bottom rail track with mechanical equipment.

2. Adjustment of joints.

3. Replacing sleepers.

4. General tightening up of wood screws.

5. Ensuring that the fastenings are in good order, i.e. :

— recut the shoulder piece,
— restore to gauge,
— put in the spikes,
— final tightening of wood screws, spikes, etc.

6. Replacing sleepers.

7. Clamping the sleepers (can be done any time before levelling the track).

8. Levelling the track.

9. Levelling off.

The various operations, which ought to be carried out in the order given above, can be done separately either by gangs following one another at convenient distances, or by gangs which do various simple operations in turn and then are grouped together to carry through more complicated tasks.

As a rule the total strength of the gang should correspond with the number of men needed to do the most important work which, on old tracks, is operation No. 5 (ensuring the fastenings are in good order).

We consider mechanised equipment has its best use in operation No. 5, which covers the undoing and replacing of wood screws (screw drivers), drilling and opening out the holes (drills) and renotching the wood (cutters).

In figures 28, 29 and 30 are shown examples of the organisation of a gang equipped with mechanised equipment to carry out operation No. 5.

QUESTION XIX. — *Do you take any special steps as regards the safety of gangs using mechanised equipment?*

Some railways, Belgium in particular, treat mechanised equipment running on the rails as trains and protect them as such.

Others provide protection by look-out men as in the case of ordinary gangs.

In France the question is covered as follows :

Mechanised tools are considered noisy and more difficult to get clear of the track than hand-operated tools.

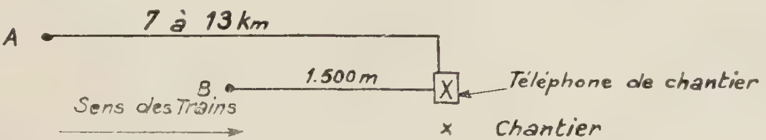
If few in number and easily lifted clear, the usual protection by look-out is considered sufficient. If not, their protection is provided as follows on double track line :

In the case of single track the above arrangements are made on both sides of the job in hand.

QUESTION XX. — *Have you any maintenance gangs lodged in maintenance trains?*

Holland alone possess a maintenance train. Finland only used one during the war.

With the S.N.C.F. the lodging of gangs



Explanation of French terms:

7 à 13 km = 4 to 8 miles. — Téléphone de chantier = Telephone at site of work. — Sens des trains = Direction of trains. — Chantier = Site of work in hand.

A look-out man, A, connected by telephone to the depot, reports a train passing. This look-out man is placed 7 to 13 km. from the point to be protected, according to the speed of the train and the time needed to clear the line with the type of equipment being used and the number of units in use. A second man, B, at 1 500 m. from the site of the work has to stop the trains if he has not had instruction from the man in charge of the work not to do so. He is connected by telephone to the site of the work in progress.

As soon as the look-out man, A, advises of the approach of a train, the man in charge of the work clears the track and then, if there is no reason to the contrary, instructs the second man, B, to withdraw.

Look-out men (one or several according to weather conditions) are protecting the working men with regard to the trains running on the adjoining track.

in trains is practised in the following circumstances :—

- Work done in areas where there is a shortage of labour.
- Gangs specially formed to restore quickly a defective section.
- When renewing sections of track.

When maintenance sections have been mechanised it is better for the use and upkeep of the machines to be confined to one set of men, as much as possible. This staff, which should be limited to the minimum, can be lodged either in a train or a single section van, extra labour being supplied from local or neighbouring gangs.

QUESTION XXI. — *Do you use rail cars, motor trolleys, or lorries to collect the staff of the large mechanised maintenance gangs?*

Finland reports the use of motor trolleys for collecting the gangs and Switzerland the use of tractors in addition to special stops of slow trains.

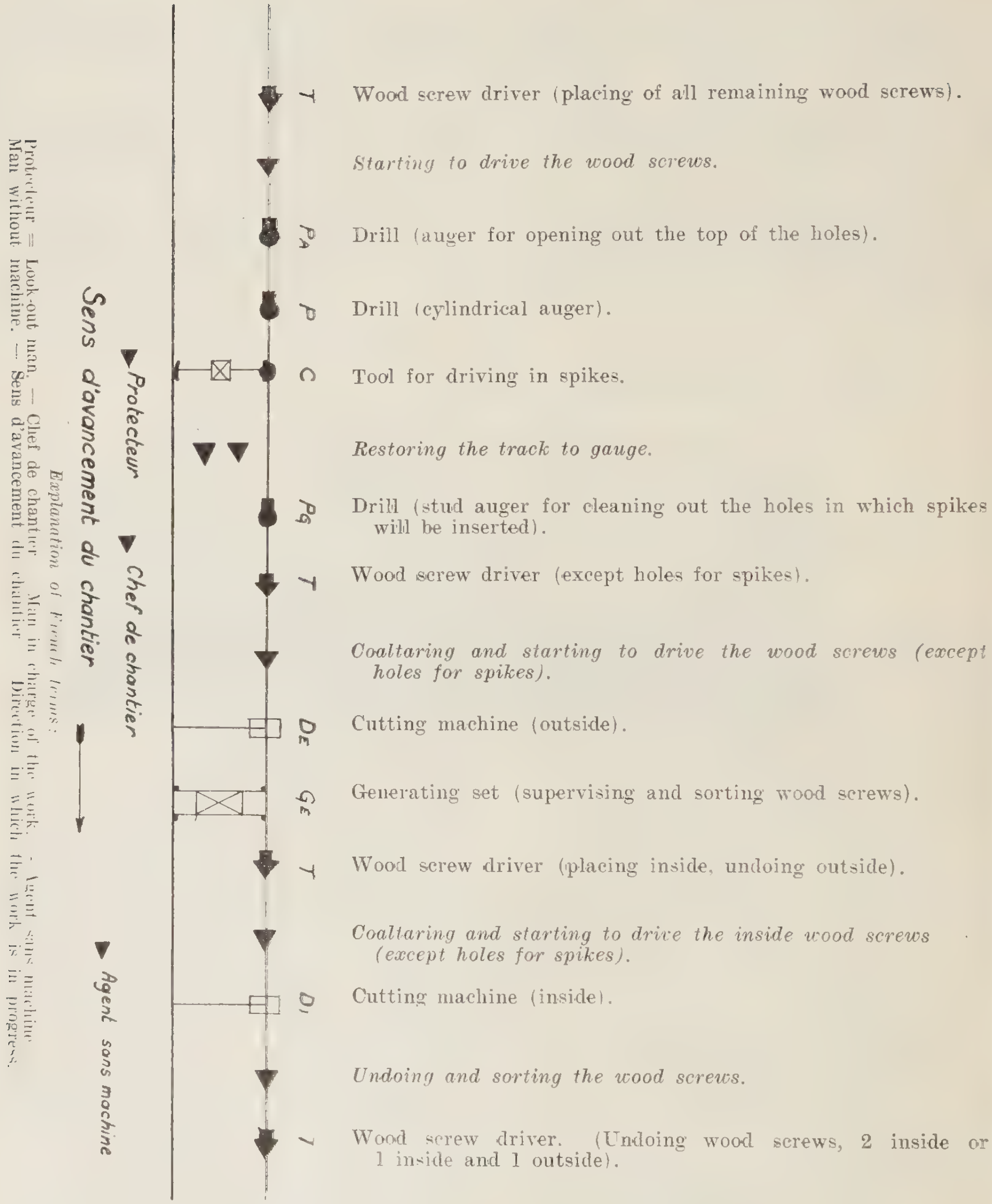


Fig. 29. — Organisation of the work of the maintenance gangs, flat bottom rail track.

Allocation of staff and appliances used during the work.

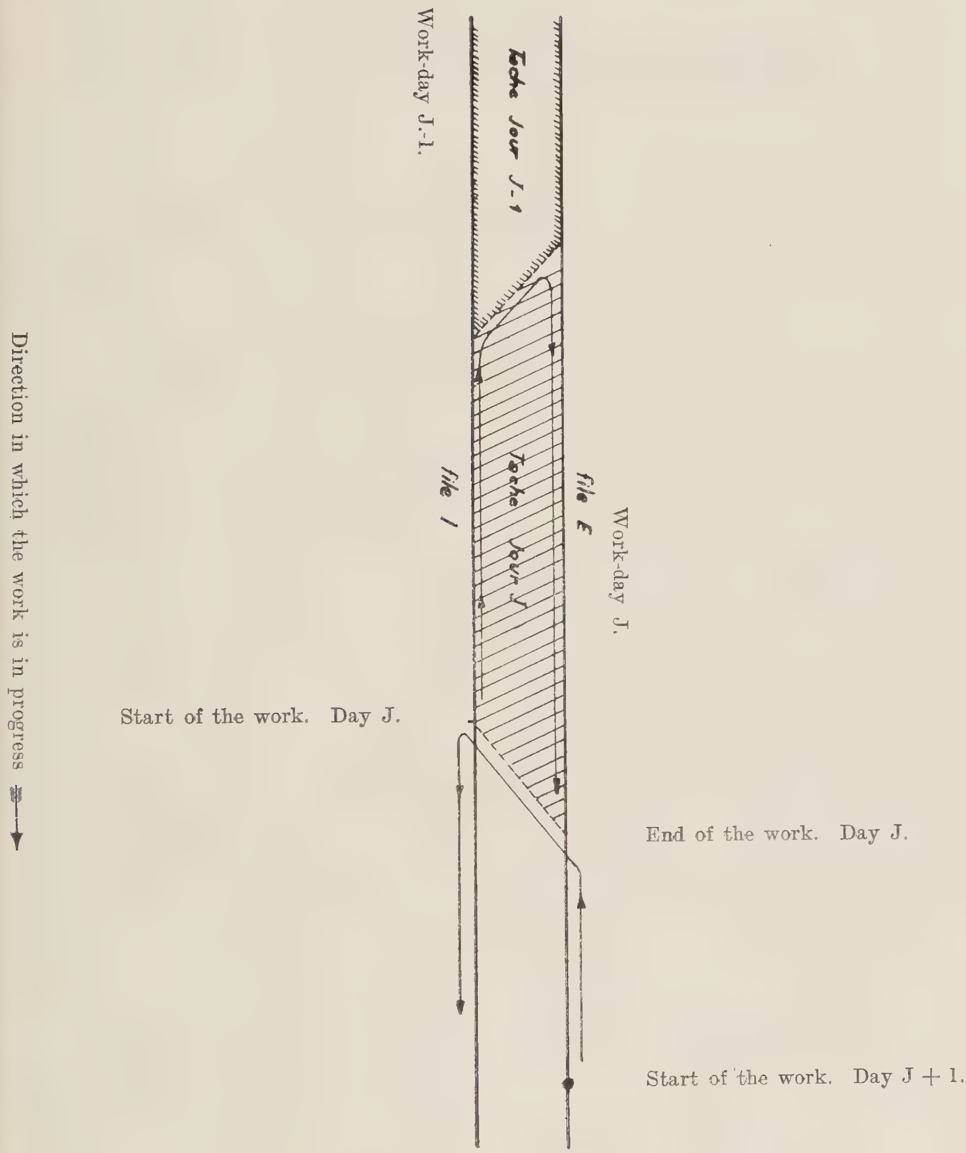


Fig. 30. — Output in a days' work.

In France, the following are used, according to requirements :—

- ordinary slow trains either stopping actually at the site between stations to set down and pick up staff, or to collect the staff at the nearest station;
- trolleys;
- lorries.

The method of transport used depends upon the circumstances and local conditions (size of the gang, location of the job).

* * *

CONCLUSIONS — PART I.

From the replies received the mechanisation of the permanent way must be regarded as still in the experimental stage.

Mechanisation gives better returns when the work to be done is considerable, that is to say, when the track is older and labour is scarce and expensive.

To ensure good use is made of the tools, work must be very carefully organised.

For the tools to be properly used and maintained they should be in the hands of specialised staff.

When the tools have been properly adapted to the work to be carried out and their use thoroughly understood, it is probably preferable to give a large part of the maintenance work to gangs covering zones of 50 km. or more and leave light repairs, inspection and accessory work on the subformation to the local gangs which have been reduced in numbers.

The question before us is not a new one. At the 1930 Madrid Congress, Question IV was as follows :—

« Recent improvements in permanent way tools and in the scientific organisation of maintenance work. »

At the 1933 Cairo Congress, Question II was as follows :

« The use of mechanical appliances in the permanent way maintenance and in track relaying. »

On reading the reports in question it is seen there has been little progress since 1930-1933. We may be forgiven for ascribing it to the 1939-1945 war.

We would recommend that the discussion of Question IV at the Madrid Congress be read and feel it will be useful to reproduce an extract of the contribution made by M. TETTELIN (of the French Nord Railway) (*), which seems to us to be still equally valuable :—

« The mere existence of mechanical plant, from the fact that decision is made to use it, requires an organisation of the labour which is going to use it, an organisation totally different from that set up when there was no mechanical equipment.

» When speaking of the regular distribution of personnel along the line, one is under the domination of a state of affairs which did not include mechanical plant.

» There were then, along the line, gangs of five or six men, having hand tools, with which, from one end of the year to the other, they strove to maintain the track in good condition. But if it is decided to put the mechanical tools into use, tamping machines, coach-screw driving machines, it is not five men who are going to use them; it requires, in order to justify them, a special equipment which will travel from one end to the other of the line and which in its campaign will do 80 to 100 km. (50 to 62 miles) of complete track maintenance.

» This maintenance of the tracks with flat-bottomed rails — I have this

(*) See *International Railway Congress Bulletin* for December 1930, p. 2256.

kind in view — fixed by coach-screws and not by spikes, consists essentially of ensuring the constant tightening of the fastenings. The coach-screws must firmly hold the rails, so that there is no play between the rails and the sleepers; the sleepers must rest solidly on the ballast to avoid any dancing sleepers; that is the object of regular maintenance; the tamping and coach-screwing machines are perfectly suitable for these purposes.

» When the work has been done from one end to the other of the line, the latter can be let alone for a certain period during which there is no necessity for any labour.

» One can then imagine an organisation in which the workshop with the tamping and the coach-screwing machines would travel along each section of the line at intervals shown by experience to be suitable. As to the permanent personnel of the line, it will be greatly reduced, because there will scarcely be any need to concern oneself with the track between two visits of the mechanical equipment; consequently, on the understanding that we are discussing here the question of mechanical plant, we must carefully abstain, seeing we are just beginning to use it, from making rules prescribing the manner of its use, or from confusing this use of new equipment with old methods not including mechanical appliances. »

Tools continue to be improved. Many railways are trying them and others are about to do so. The stage of trial and improvement of these tools is nearly completed. The use of this equipment by organised gangs is in being and there is no doubt that valuable savings and better work will result. It is hoped that the question will be put on the Agenda of a further Congress.

II. Mechanisation of permanent way renewal.

QUESTION XXII. — *When reconditioning the permanent way do you use any special machines to remove the old ballast and lower the bed formation? Give brief particulars of the arrangements made for reconditioning the formation on bad ground.*

In Sweden a special wagon, known as a « plough wagon », fitted with a plough to remove the old ballast, is used on double track lines. This collects the ballast and deposits it in a ridge alongside the permanent way. The same appliance is also used as a spreader when re-ballasting with broken stone. The same equipment is used in Holland.

On other railways this work is carried out by hand.

As regards methods of reconditioning the formation on bad ground, the Spanish Railways merely provide cross and longitudinal drainage. In the case of particularly unstable cuttings, reinforced concrete dams are provided in addition.

The other railway administrations, when reconditioning the permanent way, lay a mattress of sand with a layer of clinker over it between the formation and the ballast and complete the work when necessary by suitable drainage.

In Switzerland, in some instances, a bituminous covering 0.05 to 0.07 thick, is added. In Holland, in the case of particularly bad ground, the formation is consolidated by means of a slab of ordinary concrete or reinforced slag.

In France the ballast is usually lifted by mechanical diggers used to screen the ballast.

Excavation to lower the formation is generally carried out by hand on normally operated lines.

Clay is covered with a mattress of fine sand (such as sand from dunes) 0.20 to 0.30 thick. To prevent the ballast sinking into this bed, a layer of clinker,

about 0.05 thick, is laid between the sand and the ballast. This method has been in use for more than 20 years and is quite satisfactory when the problem is to keep rain water off the formation. Water from underground sources should be properly collected and drained away.

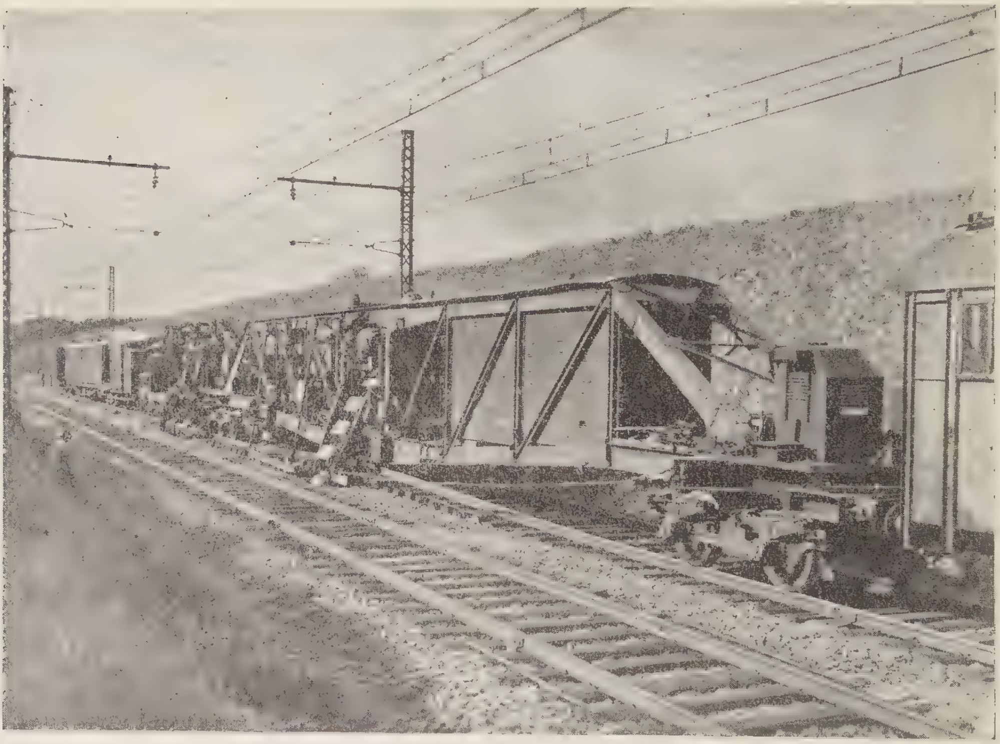


Fig. 31. — « S.E.C.O. » ballast remover.

QUESTION XXIII. — *Have you tried to stabilise the formation by grouting with cement?*

The whole of the railways reply in the negative.

QUESTION XXIV. — *What equipment are you using to remove and screen ballast?*

Switzerland reports using the «Scheuchzer » ballast remover and screener when the work can be done at night or by occupying the line for a certain period, or when there are sufficient intervals between trains, otherwise the work is done by hand.

In Spain, too, a « Scheuchzer « ballast remover has been used for the renewing of the Linares-Almeria line.

Except in Belgium, where mechanised equipment which has not been described, is used to clear the ballast, all railways normally carry out this work by hand.

In France the following equipment is used :

1. A « Drouard » ballast removal train,

necessitating the occupation of two tracks.

Output : 150 to 180 m. (492′ to 590′) per hour.

2. « Scheuchzer » ballast remover, operating on the line being cleared.

Output : 60 to 80 m. (196′ to 262′) per hour.

These appliances were described in the reports by Messrs. Domingo MENDIZABAL-FERNANDEZ and Joaquin GARCIA-GARIN, in Question II at the XIIth Session (Cairo, 1933) (*).

3. « S.E.C.O. » (Société d'Etudes et de Constructions d'outillage) ballast remover, working on the line to be cleared (fig. 31).

Output : 200 to 300 m. (656′ to 984′) per hour.

(*) See *International Railway Congress Bulletin* for August 1932.

This plant is made up of three wagons :

— The first carries a generating set supplying power to the various tools, digger, screen and transport of the products.

— The second wagon carries the ballast remover itself and includes :

gear for adjusting the depth to which the ballast is removed;

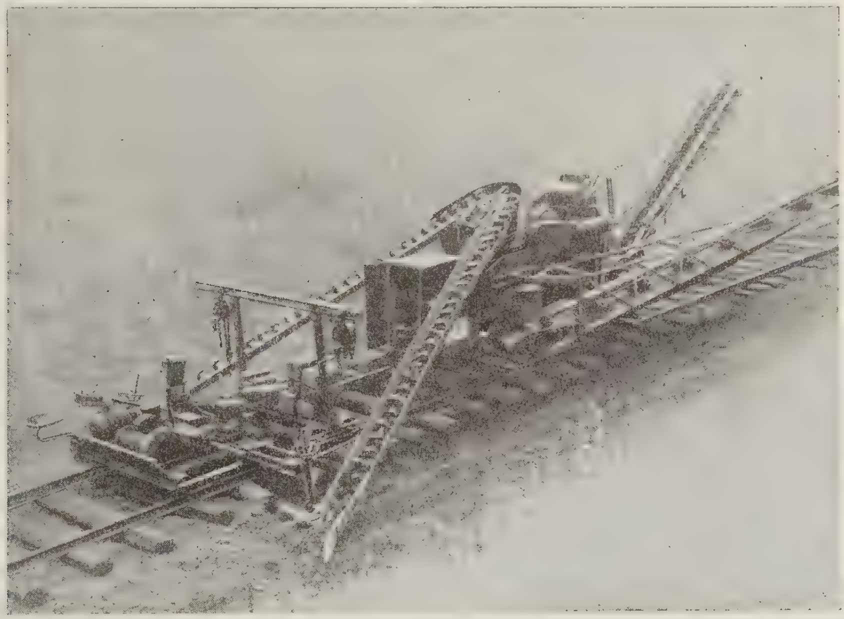


Fig. 32. — « Drouard » ballast remover.

an excavator, the buckets of which are fitted with teeth to break up the ballast to be screened. This excavator travels under the track which has been lifted by the « guiding chain »;

a belt to feed the old ballast to the screens;

a belt to feed the screened ballast back under the track;

a plough to spread the ballast and regulate the height.

— The third wagon carries the screen in which is separated, by vibration, the usable ballast from the waste to be discarded.

Additional equipment has been added recently by means of which the small gravel for packing is recovered and is placed in heaps along the track.

The output is 60 to 80 m. (196′ to 262′).

This equipment has an endless scraper chain which covers the full width of the track and works on an inclined plane.

This chain, guided in a trough, passes under the sleepers, picks up ballast continuously and discharges it into an

Fig. 33. — « Collet-Loiseau » plant.

inclined trough, from which it passes on to a vibrated screen on which the usable ballast is separated from the waste.

The recovered ballast is dropped on to the line or is placed along it. The residuals are thrown clear of the formation.

The machine is moved whilst working by being drawn by a wire rope anchored

The « S.E.C.O. » ballast remover is hauled along the track by means of a wire rope anchored at the front end to a fixed point, usually a locomotive : the rope is wound round a drum fixed at the front of the first vehicle.

4. « Drouard » ballast remover which works on the line, the ballast of which is to be removed.

at its leading end to the track. The wire rope is wound round a drum carried on the front of the ballast remover.

In France, the following equipment is in use :

— the « Drouard », which occupies two tracks;

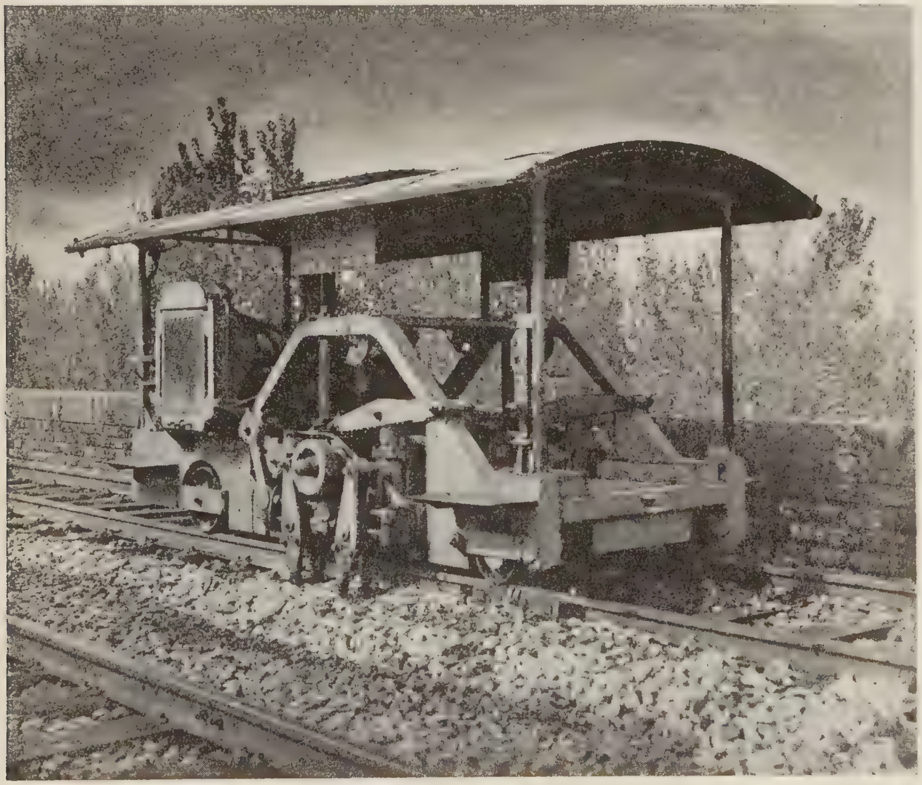


Fig. 34. — « Matisa » mechanical tamper.

QUESTION XXV. — *What plant do you use to take up the old track and relay the new?*

Tests are reported by Sweden and Switzerland with the « Collet » plant for taking up and relaying the track.

Finland occasionally uses ordinary cranes.

Generally speaking, railways carry out this work by hand.

— the « Collet-Loiseau », which occupies only the track being dealt with.

These two methods have been described in the report on Question II for the XIIth Session (Cairo, 1933), referred to in the previous question.

A detailled description of the two systems was given by M. TETTELIN, Chief Engineer, Permanent Way, of the Nord Railways, (*Revue Générale des Chemins*

de fer, October, 1929 — *Bulletin of the International Railway Congress Association,* May, 1932), and by M. PATTE, Chief Engineer, Est Railways, (*Revue Générale des Chemins de fer,* April, 1931).

We need not, therefore, give a detailed description of these methods other than to report that in 1948 an output of over 500 m. (1 640′) per working day was obtained on several sections with the « Collet-Loiseau » (fig. 33) equipment.

In the case of renewal involving the replacing of the ballast, whether the track and the ballast is renewed or the ballast alone, the first levelling is done :

by lifting with special shovels,

by lifting with a mechanical tamper.

When the track has to be renewed without replacing the ballast, but involving a change in the sleepering, the first levelling is done :

Fig. 35. — Loading rails.

QUESTION XXVI. — *What equipment are you using to lift and level new track?*

All railways, after relaying, lift the track with jacks of various types, using boring rods, straight edges, levelling boards, beaters, or special shovels which allow dirt, etc., to drop through.

In Luxemburg the work is carried out by tamping and shovel packing.

In Holland and Switzerland « Matisa » mechanical tampers are used.

The method used in France for levelling new track varies according to circumstances.

— preferably by mechanical tamping so as to remake quickly the bearings,

— or by packing with small gravel; this method of levelling consisting of introducing under the sleepers a quantity of small gravel corresponding to a general relifting of 3 to 5 cm. ($1^{3}/_{16}''$ to $2''$).

The track is then put in order by measured shovel packing.

Mechanical tamping in France is carried out mainly with the « Matisa » type appliance (fig. 34).

The different types of mechanical tampers and the various methods of

levelling were described by M. LEDUC, Chief Engineer, S.N.C.F., in his report to the 14th Session of the International Railway Congress, published in the *Bulletin* of March, 1947.

QUESTION XXVII. — *Are special wagons used for the conveyance of rails and for off-loading them?*

(a) *Rails of normal length.*

(b) *Rails of great length.*

Most of the railway administrations have replied in the negative. The wagons used are ordinary traffic wagons, coupled together to carry very long rails.

— standard gauge trucks which have a low loading platform and can carry heavy loads (figs. 37 and 38).

The load, which may be up to 40 rails, is carried on two trucks rigidly coupled together by beams of appropriate length for the rails to be carried.

Before the trucks can be coupled together the inner buffers and drawbars have to be removed.

So that 24 and 36 m. rails may be loaded and unloaded as quickly as possible, special « Robel » type equipment is used in Switzerland. This equipment, when in use, is fastened to the solebars of the trucks.

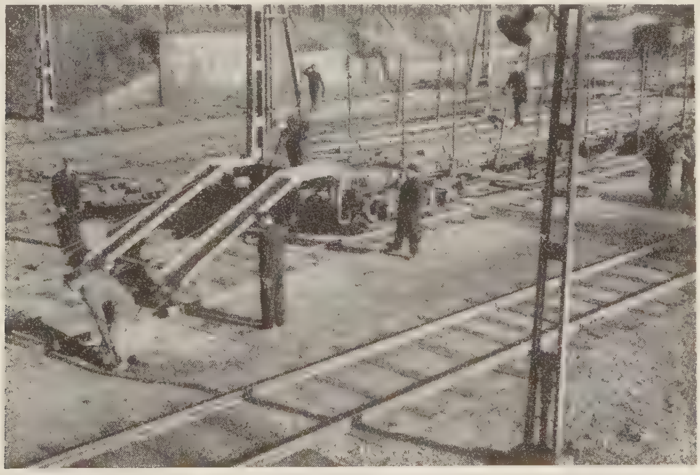


Fig. 36. — Loading rails.

Sweden reports the use of a special arrangement for loading and off-loading rails by using two ramps at the end of the last wagon (figs. 35 and 36).

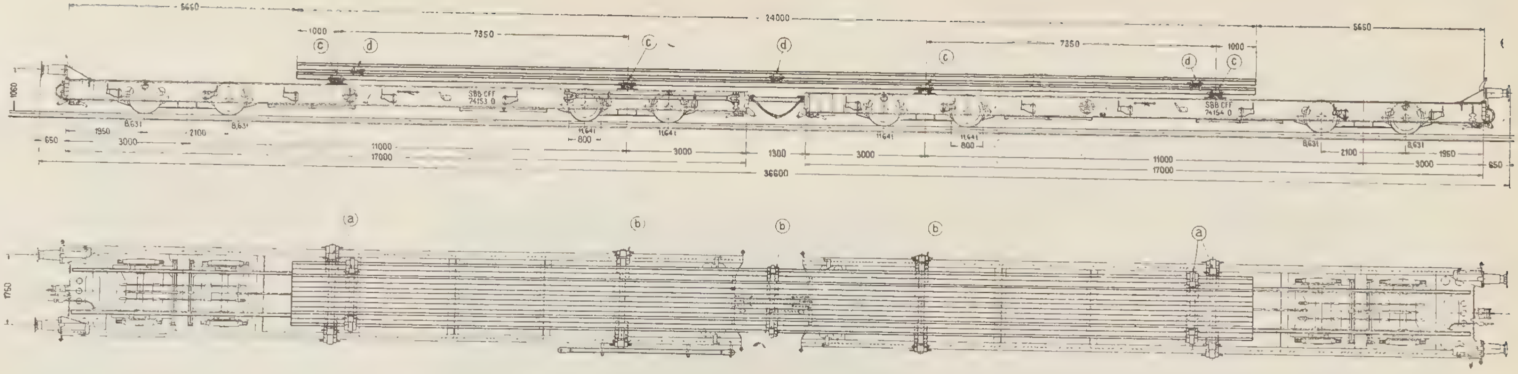
Switzerland has introduced special arrangements for the conveyance of rails 24 to 36 m. (78′9″ to 118′1¼″) long. For this purpose :

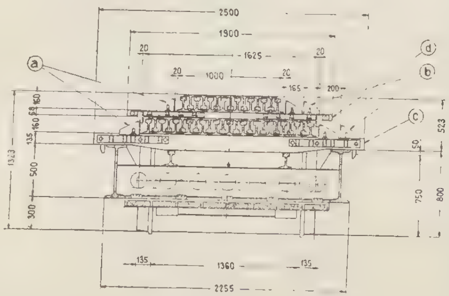
— either two or more wagons coupled together, according to the types, or, preferably,

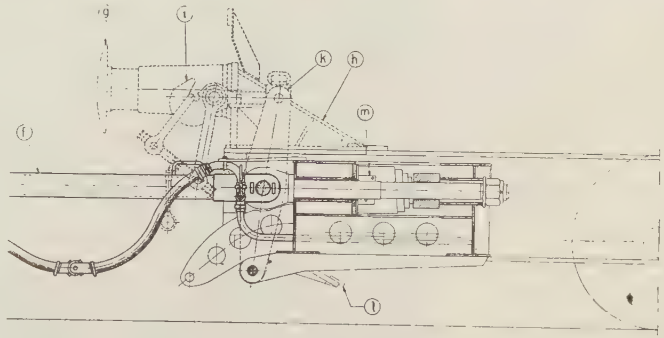
Each set of equipment consists of a crane with revolving jib (fig. 39), two sets being used for 24 m. rails and four for 36 m. rails.

In France, ordinary traffic wagons coupled together are used to carry long rails.

Rails at the rail depots are loaded and unloaded by means of demountable gantry cranes over the wagons with a winch, usually hand-operated.







Legend.

Series	Tare t.	Normal load t.	Whole useful length m.	75 % normal load t.	Maximum axle load t.	Weight loaded t.	Number of rails	Reversal system on « loaded » for number of rails of
O / O	18.5 / 18.5	43 / 43	34.6 (113′6″)	32.25 / 32.25	16.0 / 16.0	44.09	40	38

Stops

(a) rows lower and upper without play.

(b) rows lower and upper with part clearance

Tackles

(c) wood beam with even surface

(d) intermediate beam

(f) tie-rod length 1 540 mm. (5′ 11/16″)

Pieces taken down for transport separately

(g) buffers

(h) buffer support

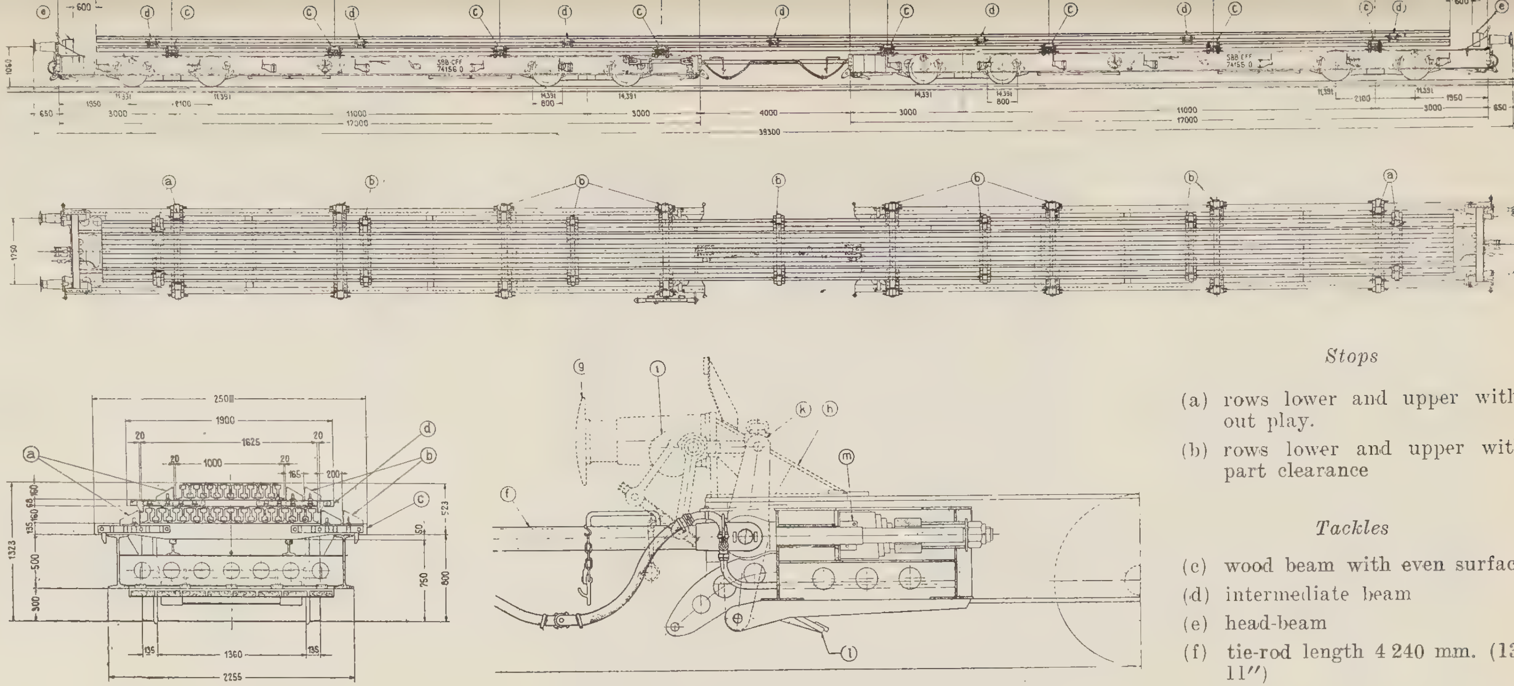
(i) standard coupling

(k) lever of the draft hook

Pieces shifted for the transport

(m) safety key

(l) tip-supports



Stops

(a) rows lower and upper without play.

(b) rows lower and upper with part clearance

Tackles

(c) wood beam with even surface

(d) intermediate beam

(e) head-beam

(f) tie-rod length 4 240 mm. (13′ 11″)

Pieces taken down for transport separately

(g) buffers

(h) buffer support

(i) standard coupling

(k) lever of the draft hook

Pieces shifted for the transport

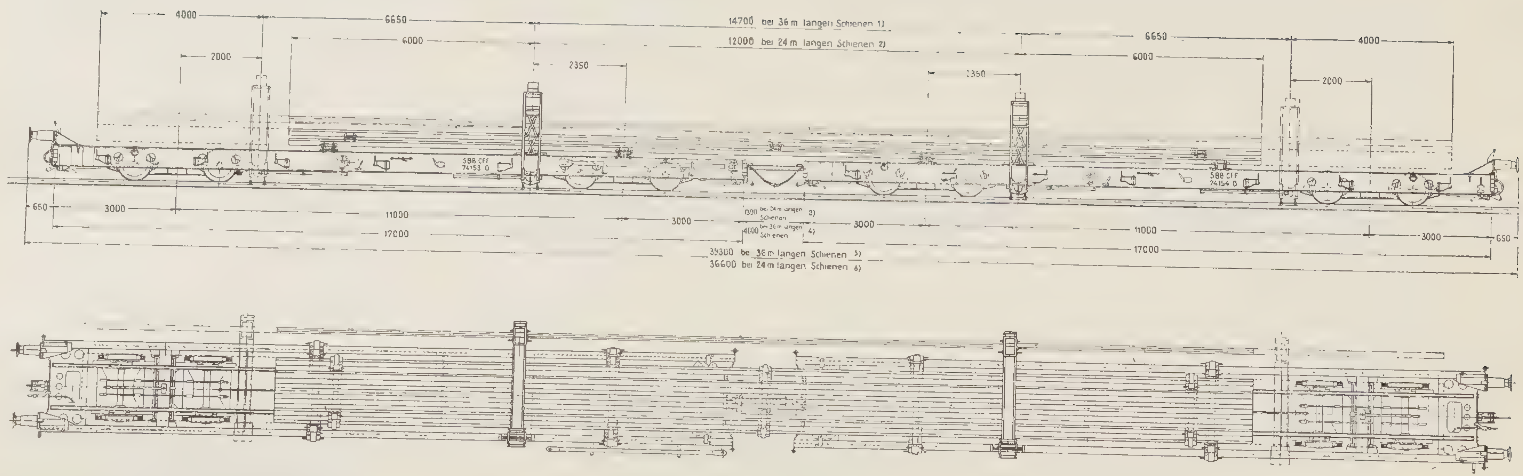
(m) safety key

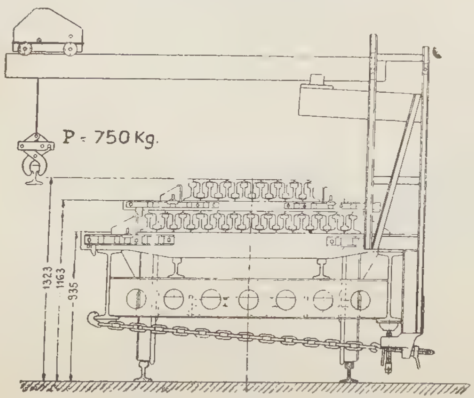
(l) tip-supports

Legend.

Series	Tare t.	Normal load t.	Whole useful length m.	75 % normal load t.	Maximum axle load t.	Weight loaded t.	Number of rails	Reversal system on « loaded » for number of rails of
O / O	18.5 / 18.5	43 / 43	37.3 (122′4½″)	32.25 / 32.25	16.0 / 16.0	66.15	40	26

Fig. 38. — Standard gauge trucks for loading 36 m. (118′) rails.





1) 14 700 for rails of 36 m.

2) 12 000 for rails of 24 m.

3) 1 300 for rails of 24 m.

4) 4 000 for rails of 36 m.

5) 39 300 for rails of 36 m.

6) 36 600 for rails of 24 m.

Fig. 39. — Standard gauge trucks for loading 24 and 36 m. rails.

« Robel » type equipment for loading rails.

One Region, the Est, uses bogie wagons fitted with special pillars with hand-operated winch.

The Nord uses different equipment to handle the 18 m. (59′5/8″) and the 24 m. (78′9″) rails.

The 18 m. rails are carried on ordinary bogie flat wagons, provided with 2 gantries with differential pulley blocks for loading.

In Poland a number of types of wagons of about 35 tonnes (34.447 Engl. t.) capacity are used, but no details have been sent.

Finland reports the use of special hopper bottomed wagons with side discharge.

In Denmark special automatically discharging wagons are in use, but no description has been supplied.

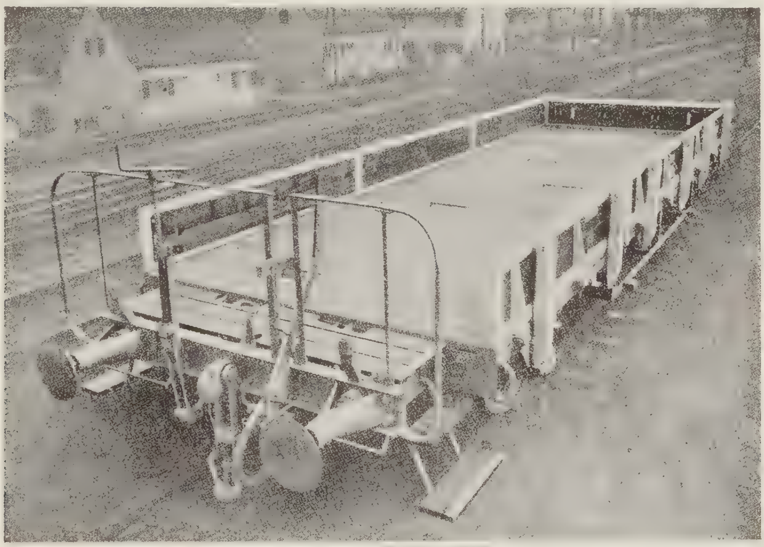


Fig. 40.

The 24 m. rails are carried on specially fitted wagons.

These arrangements were described in the *Congress Bulletin* for August 1932 (Question II, XIIth Session, Cairo, 1933).

QUESTION XXVIII. — *Are special wagons used for conveying and unloading ballast?*

Special wagons for carrying ballast are used relatively widely.

In Sweden and Morocco the « Talbot » wagon, which has been described frequently, is used.

In Luxemburg and Belgium, hopper wagons are used.

In Holland, small side tipping containers, carried on flat wagons, automatic discharging wagons and hopper wagons are used; details of the types used have not been given.

The « Rhätische Bahn » has two « Ochsner » type ballast wagons.

In Switzerland, at the present time, wagons primarily intended for carrying ballast are in use (fig. 40). These 18 tonnes (17.715 Engl. t.) wagons are fitted with 5 doors in the floor, con-

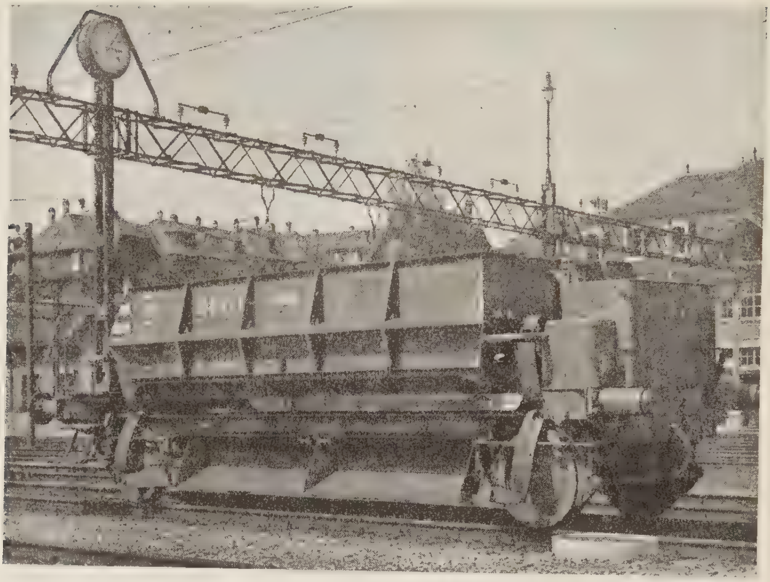


Fig. 41. — Ballast wagon.

Fig. 42. — Hopper wagon, S.N.C.F.

trolled by a single lever on the floor and with inclined plates under the floor openings to ensure the ballast falls between the rails.

These vehicles can be used to carry other materials; stanchions can be added to ensure the available capacity is used to better advantage.

In Switzerland wagons with tipping hoppers (fig. 41) are used as well.

In France « Talbot » wagons are used mainly. The Nord region use wagons, the hoppers of which are carried on ordinary underframes (fig. 42).

only and also providing one of the two lines is removed.

Particulars of the way in which this machine works, and how it is used have not been given.

At the present time, no special equipment is used in France to level the unloaded ballast when renewing.

The « S.E.C.O. » ballast remover screen (see XXII, above), however, is fitted with a levelling bar which spreads the recovered ballast returned to the formation after screening by the machine to the proper depth under the sleepers.

Fig. 43. — Transport of pre-assembled lengths (work).

QUESTION XXIX. — *Have you any equipment to spread the ballast discharged?*

Sweden and Holland use the plough or ballast spreading wagon, mentioned under Question XXII, for levelling the ballast when renewing the track.

In Sweden it is considered that this system effects a considerable saving in time, but, in Holland, the system is considered suitable for double track lines

QUESTION XXX. — *Do you roll the ballast before laying the new track?*

In Sweden, when renewing the track after removing the old ballast, the formation is rolled by a compressing roller to get a regular layer of ballast.

After having adjusted the depth, the ballast is then rolled to bring its upper surface to within a few centimetres below the lower face of the new sleepers.

Holland also rolls the ballast by ma-

chines which vibrate the ballast as well as pack it. The machine used is the « vibro-packer » of the Société Générale du Matériel d'Entrepreneurs of Antwerp, Belgium.

Luxemburg and Denmark also report some trials with the rolling of ballast.

Belgium is also doing this, but only on new ground by using a motor driven « Demag » roller.

In Indochina, when restoring the condition of the permanent way, the mattress of laterite only is rolled and the ballast is lightly packed.

In the Nord Region of France, tests are in hand of rolling the ballast when renewing.

QUESTION XXXI. — *Do you assemble the tracks in workshops and carry them to the site on special wagons?*

If you do, please give details of the mounting on site and particulars of the equipment and wagons used.

How do you off-load lengths of track and put them into position? Give details of the length of rails used.

Generally speaking, the Administrations report that the track is assembled on the site.

In France, to feed the « high capacity » working gangs, (500 m. [1 640′] per day or more), assembling and dismantling by lengths corresponding to that of the rails (18 and 24 m.) is done in special depots either in the station at the ends of the section being dealt with or at a central depot.

Fig. 44. — Train of pre-assembled lengths.

This method ensures the mechanical equipment and handling appliances are used to better advantage and the number of men reduced.

The assembled lengths are loaded in trucks and taken to the section being renewed by a train 500 m. long by means of powerful tractors or trollies (figs. 43 and 44).

The lengths are placed in position by

a « Collet-Loiseau » machine (see XXV) using a light weight service track moved as the job progresses.

The line is taken up in the same way, in lengths which are taken to the depot for dismantling.

The above equipment requires the provision in the assembly and dismantling depots, the equipment of which is most often insufficient, of a large amount of costly equipment which is used for a relatively short time. It would appear desirable that the work should be carried out at one centre feeding one or more jobs. The question of transport over long distances then arises, which necessitates the use of specially designed wagons or trollies.

The Nord Region of the S.N.C.F. assemble the track in a workshop (fig. 45), which is conveyed on wagons, loaded with 5 lengths of track placed one on top of the other. The track is reloaded on to the trollies in a station near the work site by a special gantry crane (figs. 46 and 47).

QUESTION XXXII. — *Can you give an example of the organisation for a section of line being renewed by means of mechanised plant?*

Below is given, in the form of a graph as an example, the organisation of a relaying depot on the South Western Region of the S.N.C.F. (fig. 48).

The output amounts to 500 m. (1 640′) per day.

The staff employed is divided as follows :—

SHOPS	Numbers	
	S.N.C.F.	Temporary
Assembling new lengths of track	2	27
Dismantling lengths removed	2	23
Preparatory work for the ballast remover	1	6
Removing ballast and mechanical screening		7
Disposal of detritus, preparing the bed of the paths		12
Removing and relaying track with « Collet-Loiseau » equipment	3	28
Preliminary repacking and unloading ballast		15
Setting of the track to its proper height	2	16
Mechanical tamping		2
Reballasting, levelling with the levelling staff making paths	1	22
Electric wiring	1	2
Telephone operators and look-out men	13	
Staff accompanying trains and trollies	9	
	34	160

QUESTION XXXIII. — *Do you use special appliances for lifting and for relaying points and crossings?*

In Belgium « Collet » gantries are in use.

In Sweden a special appliance is used, but no description has been sent.

In Switzerland the points and crossings are assembled near the place where they are to be used, to which they are

Fig. 45. — Assembling track lengths.

Fig. 46. — Loading pre-assembled track lengths.

carried by trollies or « Robel » rollers.

France uses « Giral » equipment and in some cases, cranes on rails.

* * *

CONCLUSIONS — PART II.

Formerly the renewal of track was carried out completely by hand, the track being cut only between trains.

Between the two wars mechanical sleeper screw drivers, ballast removers and screeners, appliances for laying complete lengths, tampers, and special wagons for discharging ballast have been introduced.

This equipment has made it possible to reduce manual labour and increase the output and so meet the manpower shortage in certain countries. The size of such plants has made it necessary for the Permanent Way departments to obtain from the Operating Department the occupation of the track for longer periods and this has resulted in the trains having to be worked at the same speed during certain periods of the day and even to trains being diverted.

The Operating Departments have had, therefore, to make sacrifices which, however, have been compensated by the reduction in the time taken to do the work.

What will be the future development of mechanised track renewal?

Sleeper screw drivers have been perfected and only detail improvements are to be expected.

Fig. 47. — Wagons loaded with pre-assembled track lengths.

The ballast removal and screening plants, generally speaking, are satisfactory. An increase in output is to be expected. The loading up of detritus has still to be made a success.

The « Collet-Loiseau » method of track laying of assembled lengths seems to be the most satisfactory at the moment. Its defect is that the stations at the ends of the section to be relayed have to be equipped at some cost to dismantle and to assemble the track. The improvement of the system should be to — reduce the number of places at which

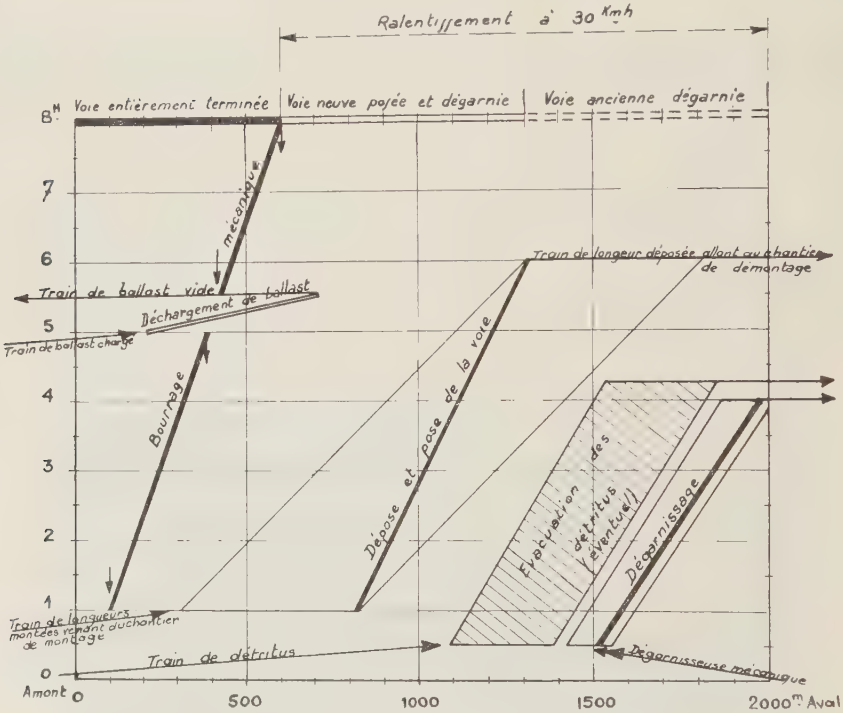


Fig. 48. — Renewal of double track line.
(The track being renewed may be occupied during 8 hours.)
Graph showing the daily output.

Explanation of French terms:

Ralentissement à 30 km/h = Speed reduced to 18 m. p. h. — Voie entièrement terminée = Track completely renewed. — Voie neuve posée et dégarnie = New track set in ballast removed. — Voie ancienne dégarnie = Old track ballast removed. — Train de ballast vide = Empty ballast train. — Train de longueur déposée allant au chantier de démontage = Train of removed lengths going to the workshop. — Déchargement de ballast = Unloading ballast. — Train de ballast chargé = Loaded ballast train. — Bourrage mécanique = Mechanical tamping. — Dépose et pose de la voie = Taking up and relaying of the track. — Train de longueurs montées venant du chantier de montage = Train of pre-assembled track from the work. — Train de détritus = Train of detritus. — Evacuation des détritus = Disposal of detritus. — Dégarnissage = Removing the ballast. — Dégarnisseuse mécanique = Mechanical ballast remover. — Amont = Up the line. — Aval = Down the line.

the track is taken apart or assembled, which would involve, however, longer hauls and more robust rolling stock;

— the transport of two or three lengths one above the other shortens the rakes and assembling or dismantling tracks, but involves the modification and strengthening of rolling stock and track laying equipment.

These improvements are at present being studied in France.

Some of the tampers now in use are satisfactory. The chief difficulty is to get the correct level in front of the tools. Here is a valuable field of investigation, both for railways and manufacturers.

The « Talbot » type ballast wagons are satisfactory and little improvement is to be expected in this direction.

23rd September 1948.

[656 .253 (.493)]

New colour light signalling adopted by the Belgian National Railways for electrified lines fitted with automatic signalling or interlocked block,

by Ir. E. J. F. DERIJCKERE,

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PART I.

CHARACTERISTICS OF THE NEW SIGNAL.

I. Reasons for adoption.

Taking advantage of the experience it had obtained with colour light signalling on the Charleroi-Namur and Antwerp-Brussels lines, the Belgian National Railways Company drew up during the war plans for installing such signalling on lines intended to be electrified.

These plans, which were based on the colour light signalling already in service, comtemplated using bracket-type signals of reduced dimensions. The arrangements decided on marked an effective step forward as compared with the existing methods. In the great majority of cases indeed the mean level of a group of lights was brought down to that of the driver's eye, the number of shunt aspects units was reduced to one per bracket signal and the grouping of the various aspects on the dolls or background plates was better than on the present colour light bracket signals. This last mentioned feature allowed of a bracket carrying three background plates, or sets of aspects, to be installed in the space available between the construction gauges in the central space of a four-track line. However, even in that case, the uppermost lights were situated at some 6 or 7 m. (19′8″ or 22′11″) above rail level.

The wish to be able to make use of bracket-type signals on lines fitted with automatic signalling and where necessary to control wrong road movements with the detailed study of the electrical circuit schemes covering the multiple combinations which can occur in practice, led to investigating the possibility of getting rid of bracket type signals altogether.

These would have presented more than twenty lights in the ordinary case of a three doll bracket group, and that bordered on an inadmissible number.

The reason for this condition of affairs was that in Belgium as on foreign railways, when colour light signalling was introduced, it was the practice to retain the aspects previously given at night by the mechanical type signals. This procedure is admissible, and even logical, as long as a few lines only have to be fitted with the new signalling and there is a mixed service thereon of steam and electric trains, but is no longer so when electrification of a railway on a large scale comes to be considered.

The problem thus arising was a big one, amounting to no less than the construction of a single type of signal capable of giving all of the following indications, namely : stop, proceed, the direction to be followed, the speed, a movement on the wrong road, take siding

(either directly or by setting back) and the various approach warnings appropriate to such indications.

II. **Description of the signal.**

The new signal in its most complete form is shown in figure 1.

It is made up essentially of three distinct parts :

1) the central portion, which exhibits the main running and shunt aspects;

2) the upper portion, which exhibits the illuminated arrow signs showing the route set up;

3) the lower portion which shows, by means of illuminated figures, the speed to be observed and also carries the subsidiary or marker lights which indicate the conditions under which a signal may be passed at danger.

As figure 1 shows, the background plate is 0.80 m. (2′7½″) wide at the bottom, which gives on a straight track a space of 0.05 m. ($1^{31}/_{32}''$) between its outer edge and the limit of the structure gauge. The upper part of the plate is 1.20 m. (3′11¼″) wide.

A free height of 2.55 m. ($8'4^{7}/_{16}''$) is thus provided above the cycle-path alongside the track. On platforms raised level with the floors of passenger coaches, the signal has to be arranged so that the centre line of its lower light is at least 2 m. (6′6¾″) above the platform surface, in order to allow for proper visibility.

When a signal is not required to give an indication of the speed to be observed, the background plate carrying the main and shunt aspects is alone provided, but it is combined with a small one carrying the marker lights already referred to. This is shown in figure 2. This gives more than 2.55 m. clear space above the cycle-path.

III. **Indications given by the lights.**

a) *Stop aspects.*

Stop is given by the red light situated in the centre of the background plate. However, in order to meet the conditions arising with automatic signalling a lunar white marker and a red marker are situated on the lower part of the signal.

The conditions under which a signal may be passed at danger will differ according to whether the white or the red marker is lighted.

The white marker burning will mean that the instruction to pass the signal at danger will be given by the head guard of the train issuing a written order (fig. 3), the train proceeding thereafter at caution as far as the next signal.

The red marker burning will indicate that such an order must be given by an assistant stationmaster or signalman, either in writing or by telephone (fig. 4).

The white marker will be lighted continuously on automatic signals situated outside station or signal box limits, even when the yellow (caution) or green (proceed) lights are exhibited.

In this way, should the power supply fail and the main aspects become extinguished, the white marker will be kept alight from another source of current and thus will permit drivers to locate the signal (fig. 5).

In addition, these signals will carry on their posts a sign in the form of a white enamelled ring indicating that they may be passed at danger under a guard's written order. In this way, the train crew will be made aware of the nature of the signal when all the lights have failed, including the marker. In the case of signals protecting fouling points and junctions, the white marker can be replaced at certain moments, through the

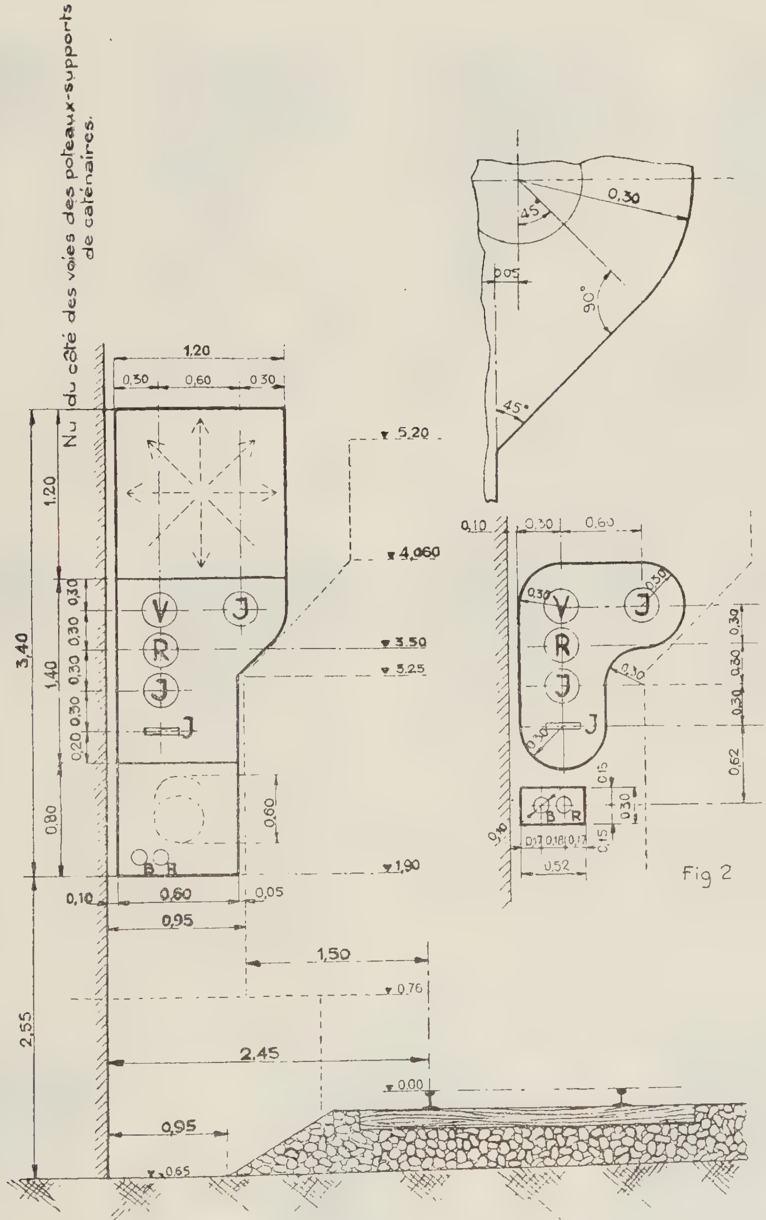

Fig 1

R = rouge
V = vert
J = jaune.
B = blanc.

Rouge = red; vert = green; jaune = yellow; blanc = white.

Nu du côté des voies des poteaux-supports de caténaires = Bare on the side of the tracks with catenary posts.

action of relays, by the red absolute stop marker.

The last named, being likewise fed from an independent source of power, will continue to burn should the feed to the main red aspect become interrupted. Then the red marker alone will show and will itself require the train to stop (fig. 6).

This last mentioned arrangement will also be adopted on lines fitted with colour light signals and operated by interlocked block (lock-and-block), since on such lines the stop aspect given by each signal controlling entrance to a block section will be the same as that given on automatically signalled sections by signals protecting fouling points.

The signals fitted with a red marker will carry on their posts a red enamelled ring indicating that they may be passed at danger only under an order from an assistant stationmaster or signalman and consequently even if all lights are out, including the red marker, the train crew will be kept informed of the nature of the signal.

These arrangements will ensure uniform practice throughout the sections of line equipped with colour light signalling.

b) *Caution or warning aspects.*

The indications to be given by the lights located in the centre of the background plate are based on the following principles :—

1) a green light will indicate that the next signal may be passed at normal speed (figs. 7 and 14);

2) a green light and a yellow, *displayed horizontally,* will indicate that the next signal is to be passed at reduced speed for some reason associated with the layout (diverging route, curve, swing-bridge, etc.);

On the next signal, there will be an illuminated numeral, coloured yellow, situated on the lower part of the background plate and giving the speed authorised (figs. 8 and 15).

3) a green light and a yellow light, *displayed vertically,* will indicate that the next signal is to be passed at reduced speed in those cases where the next two signals in advance on a line which may be run over at normal speed are located at less than the regulation distance apart. In that case the reduction in speed is called for because the second signal in advance is at danger and situated on the normal speed line (figs. 9, 16 and 17);

4) a green light and two yellow lights, *one displayed alongside and the other below the green light,* provide an indication deriving quite naturally from those mentioned in 2) and 3) above.

This indication will therefore mean reduced speed at the first signal in advance because the second signal in advance, situated on the diverging route, is at stop and is at less than regulation distance from the first one.

On the first signal ahead of the one exhibiting the warning aspect a yellow illuminated numeral on the lower part of the background plate will give the speed authorised (figs. 10 and 18).

5) two yellow lights placed diagonally at 45 degrees will indicate that the next signal ahead is at danger (figs. 11 and 19).

c) *Shunt aspects :*

1) a red light and a horizontal yellow illuminated bar authorise a movement into an occupied section of line (fig. 12);

2) a red light and a horizontal yellow illuminated bar in conjunction with a vertical illuminated white arrow sign

Stop

Fig 3

Vritten order to pass a ignal at danger to be ssued by the head guard, he train to proceed cau- iously to the next signal 1 advance.

Stop

Fig. 4

Written order to pass a signal at danger to be issued by an assistant stationmaster or a signalman.

Stop

Stop

Extinction of the main red light in a signal in consequence of a failure somewhere in the equipment.

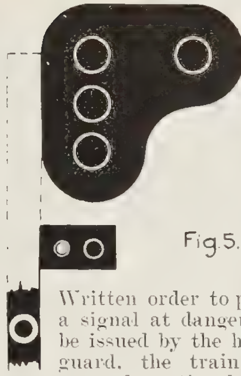

Fig. 5.

Written order to pass a signal at danger to be issued by the head guard, the train to proceed cautiously to the next signal in advance.

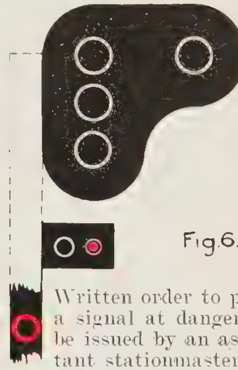

Fig. 6.

Written order to pass a signal at danger to be issued by an assistant stationmaster or a signalman.

Fig. 7.

Pass next signal in advance at normal speed.

Fig. 8.

Pass next signal at reduced speed for some reason associated with the layout of the lines.

Fig. 9.

Pass next signal at reduced speed; the two signals in advance on the normal speed line are situated at less than braking distance apart.

Fig. 10.

Pass next signal at reduced speed; the signal in advance of it, situated on a reduced speed route, is at danger and is situated at less than braking distance from the first signal.

Fig. 11.

Prepare to stop at next signal.

Fig. 12.

Shunt forward.

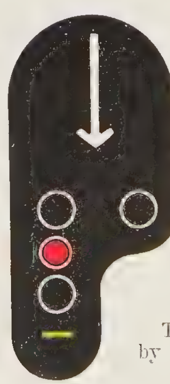

Fig. 13.

Take siding by setting back.

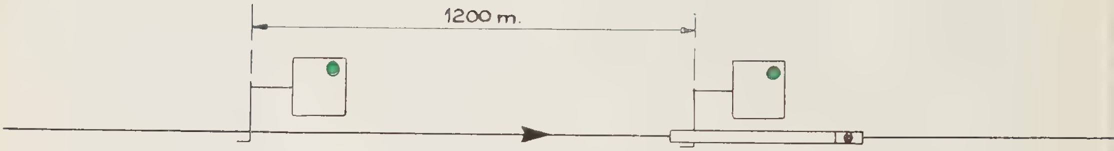

Fig. 14

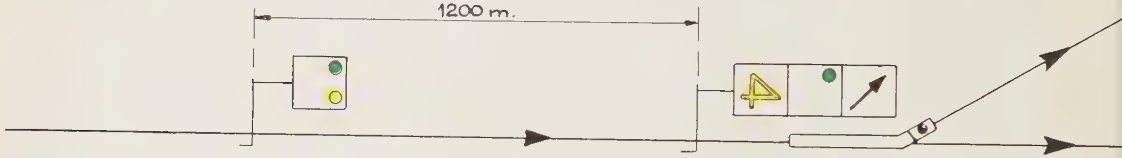

Fig. 15

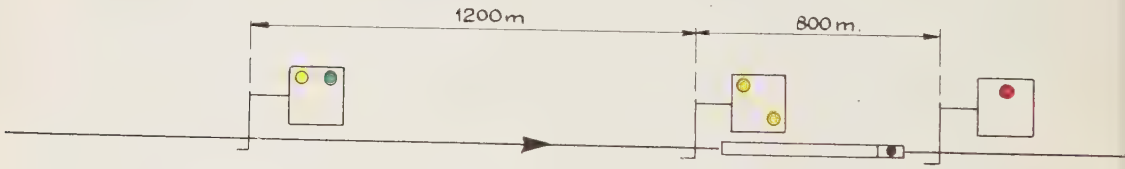

Fig. 16

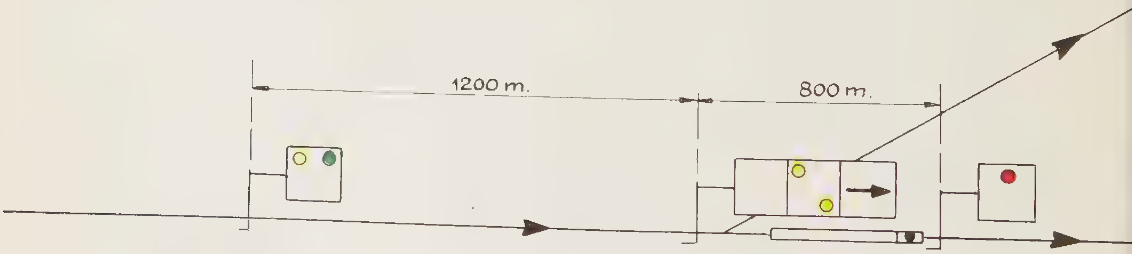

Fig. 17

(point downwards) will indicate to the driver that he is to take siding by setting back (fig. 13).

IV. Indications given by the white illuminated arrow signs.

The indications given by the white illuminated arrow signs are of two kinds :

a) *indication of the direction* to be taken by the train, replacing in improved form the indication given by the present bracket type signals [1].

The direction to be taken is given by lighting up an arrow sign after the reversal of the corresponding route handle according to the following principles :—

In order to make it easy for a driver to form a correct idea of a layout at junctions, siding inlets, etc., each signal taking the place of a bracket post signal will be preceded at a certain distance in rear by a white signboard bearing a diagrammatic representation of the junction layout and, as circumstances require, the name of the station or locality in question. These boards will be floodlighted.

The distance between board and signal will be 300 m. (984′3″) out on the open line, but will be reduced in large station areas, as local conditions may require.

The convention agreed upon in connection with the arrow signs and the signs given on their approach board is as follows :

1) vertical arrow, point upwards : direct route;

2) arrow inclined at 45 deg. to the left : first diverging route, counting from the direct route;

3) arrow lying horizontally to the left : second diverging route, counting from the direct route.

The same meanings can apply also to the right, in the case of aspects 2 and 3, and this allows of all cases being satisfactorily dealt with, as shown in figures 20 to 27.

These indications possess the advantage of being able to cover cases which cannot be dealt with in an exact manner by the present bracket post signals (figs. 25, 26 and 27), and are not open to the objection, raised against the directing light-signal aspects of other railway systems, of not allowing of distinguishing between diverging and non-diverging routes.

A system of signalling based upon the same principle has been applied in the British railways (position light junction indicator), but at the time the new Belgian signal was being designed, we were unaware of this development.

We may add here that at locations where the speed allowable when passing a signal carrying these arrow signs is less than the normal permissible speed for the section of line concerned, a yellow illuminated numeral on the lower part of the signal will indicate what that speed is.

It follows from the above that the arrow signs give purely a geographical indication of the route set up and not the permissible speed. This is a very valuable advantage, the clear separation between the functions of the various parts of the new signal.

b) *Wrong road movement indication.*

This indication which is required to be given to drivers both at the warning or distant signal in rear of the one covering the connection leading to the

(1) Route handles (manettes d'itinéraire) are not found in British signal boxes.

wrong road and at the latter signal itself, consists of an illuminated « V »-shaped sign and, in addition, the signal at the crossover carries an illuminated yellow numeral giving the speed to be observed when traversing it.

A train running on the wrong road must while so doing pay attention to any special signals situated to the right of that road. The « V »-shaped sign is required to be given on the signal last but one and also on the last signal on the section travelled over in this manner, to warn the driver that he is to retake his normal line.

Figures 28 and 29 show the indications of the signals in the simplest case of a complete movement on the wrong road (thick line) in an automatically signalled section. At signal A the white marker is extinguished, since the train is entering a section not provided with automatic signals. Signal B is the warning approach signal for the end of the wrong road movement and is located to the right of the line being run over by the train. It repeats the indications of signal C, which stands on the left of the other line before the point where the train must retake its normal road. Signal C also acts as a block section signal for normal running movements.

Figures 30 and 31 show other indications of signals B, C and D, according to the length available for making up the route concerned. Attention is drawn to the fact that on figure 31 the indications of signals B and C are those seen at the moment when signal C has just been replaced to danger, the wrong road route handle however still remaining reversed (see below).

Figure 32 shows the signal indications for entering a large station from the wrong road. Figure 33 shows the indications of the same signals in the case of a train arriving on the wrong road and being received directly into a siding at such station. In this case, it will be noted we have the « V » sign and the arrow sign at 45 deg. to the left, both over the signal, meaning direct run from the wrong line to a siding on the left.

In certain arrangements of lines we can also have the chevron sign above and a horizontal arrow.

V. Indications giving the permissible speed.

The illuminated numerals giving the permissible speed, placed on the signals, will be lighted up according to the route set up, and will be yellow in colour. The lighting of the numerals is checked electrically before a signal is cleared for a train.

In order to simplify matters and give improved visibility only the figure denoting the tens is exhibited.

This allows of the figures being made 60 cm. ($1'11^{5}/_{8}''$) instead of 30 cm. ($11^{13}/_{16}''$) high, as on the present triangular speed boards. No speed indication will be given when the permissible speed is equal to the normal speed allowed at the location concerned.

VI. Special features of the stop aspects given on the Brussels North-South Connecting Line.

The Brussels North and South stations are to be connected by three double electrified tracks running partly in tunnel, partly in the open.

There will be three stopping places in the distance of about 3 km. (3 280 yards) separating the two stations, about 750 m. (826 yards) apart.

The speed of the trains will be about

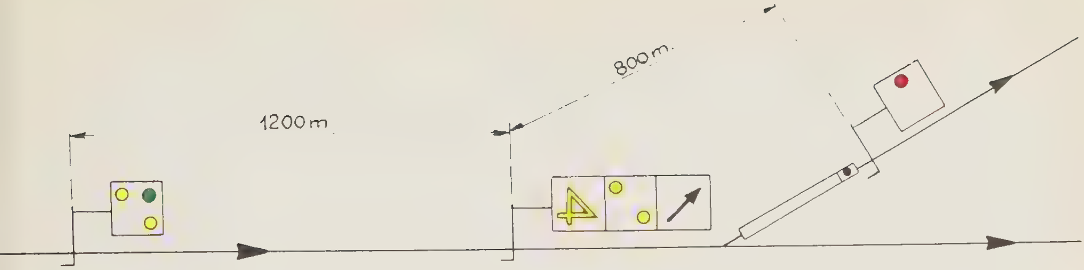

Fig. 18

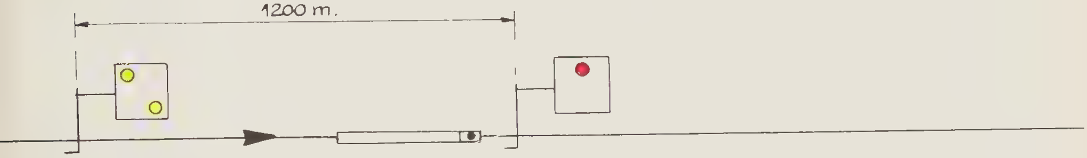

Fig. 19

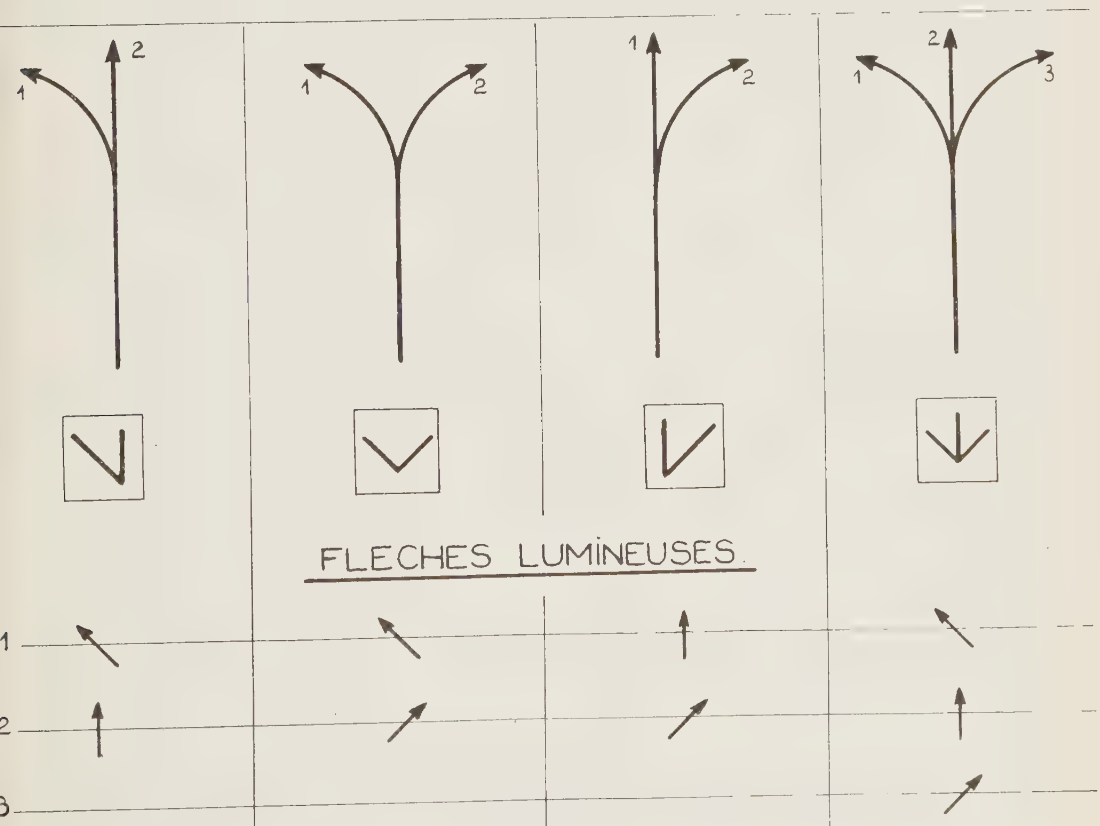

Fig 20 Fig. 21 Fig. 22. Fig. 23.

Flèches lumineuses = Illuminated arrows.

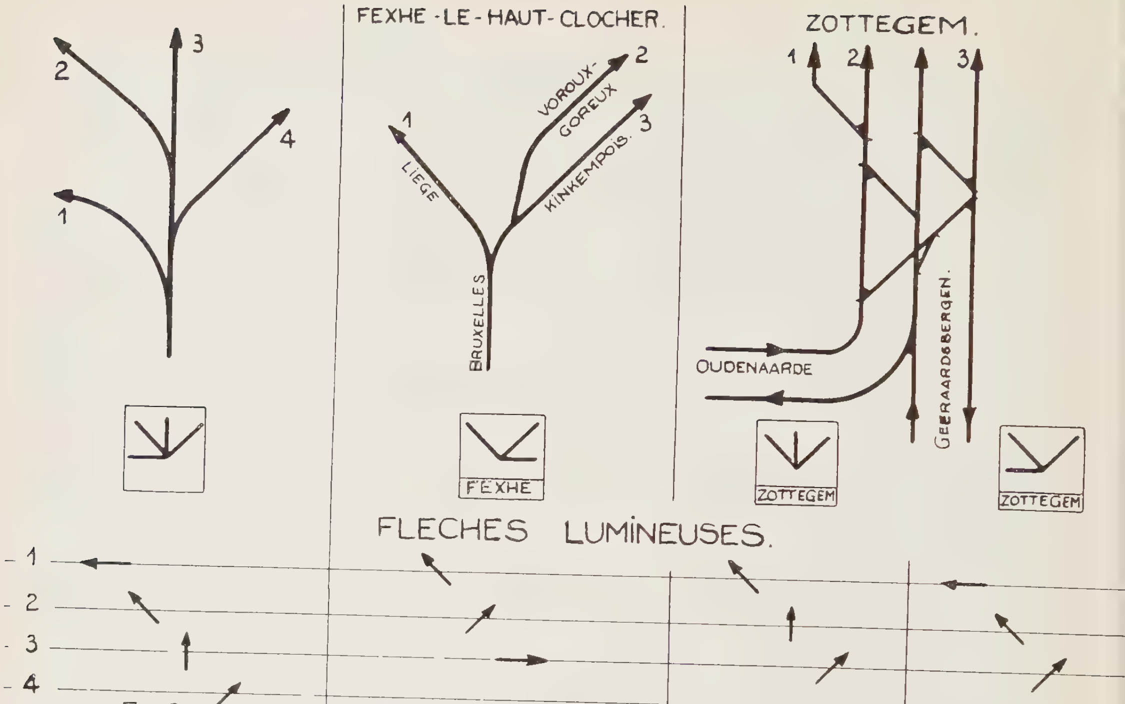

Fig. 24 Fig. 25 Fig. 26 Fig. 27

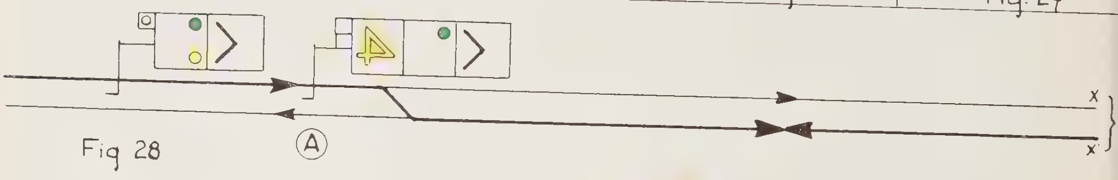

Fig 28

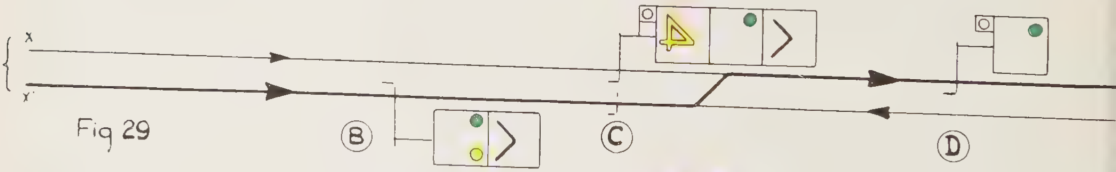

Fig 29

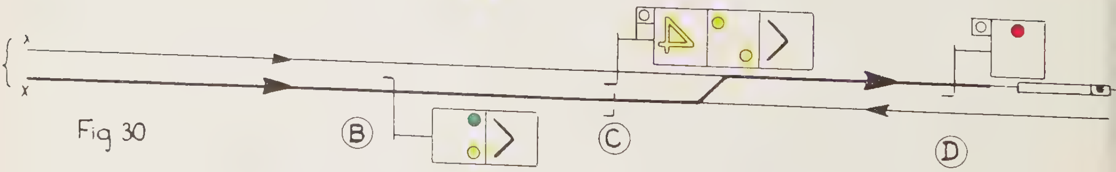

Fig 30

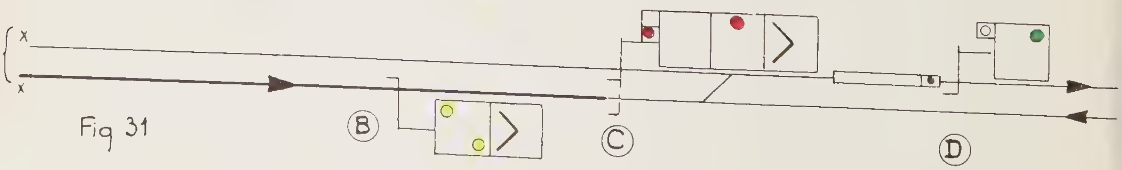

Fig 31

Flèches lumineuses = Illuminated arrows.

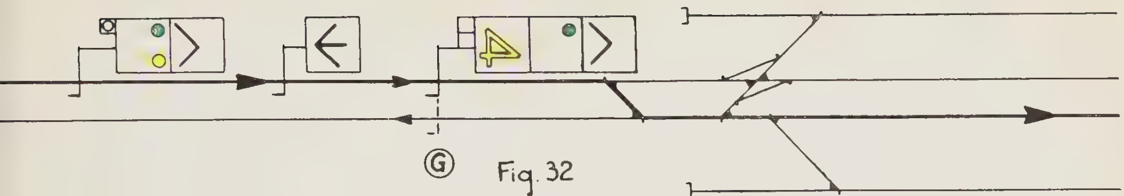

Fig. 32

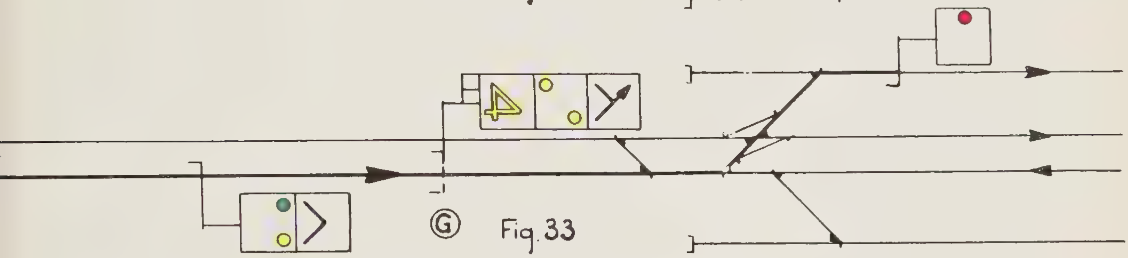

Fig. 33

Fig. 34

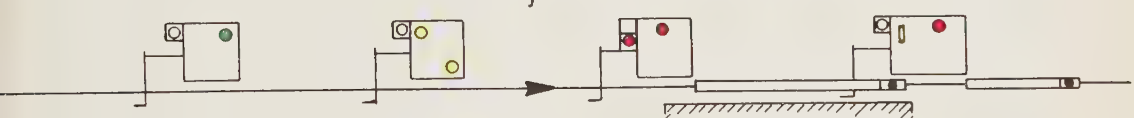

Fig. 35

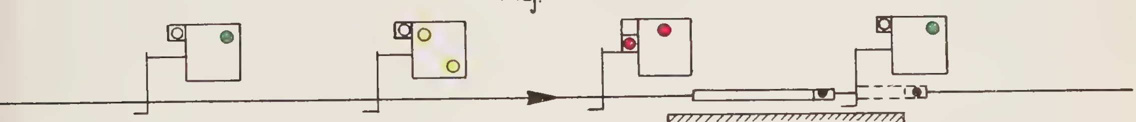

Fig. 36.

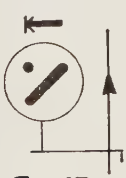

Fig. 37

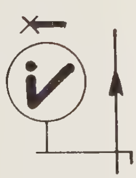

Fig. 38

Fig. 39

Fig. 40

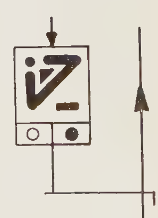

Fig. 45

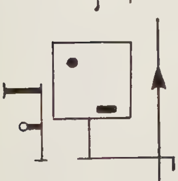

Fig. 41

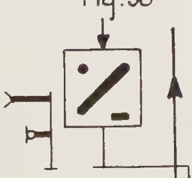

Fig. 42

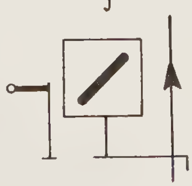

Fig. 43

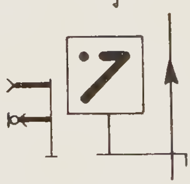

Fig. 44

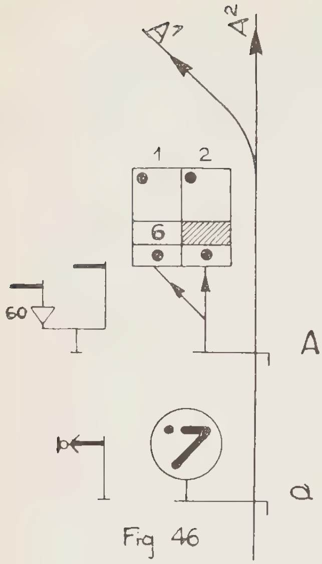

Fig 46

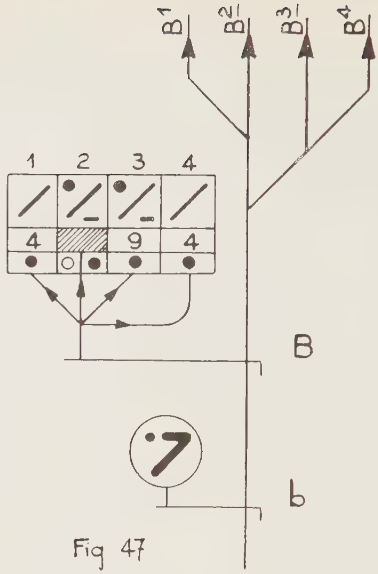

Fig 47

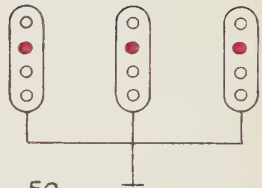

Fig 50

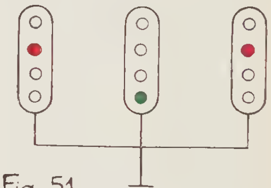

Fig. 51

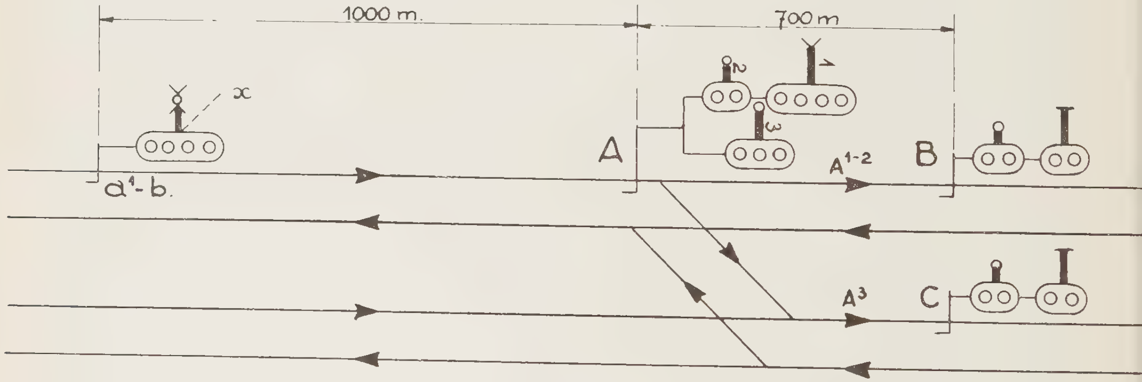

Fig. 48

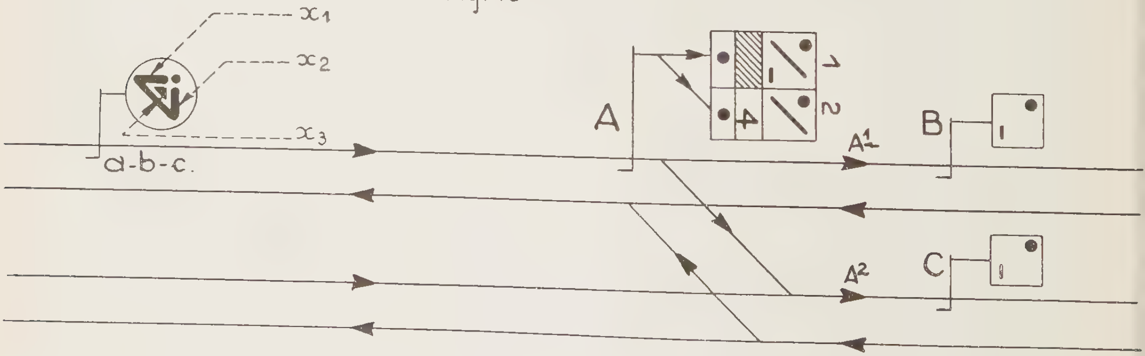

Fig. 49

50 km./h. (31 miles/h.) and as it will be necessary to pass some hundreds of trains daily the automatic signalling sections will average 300 m. (328 yards) in length.

At the stopping places it is desirable to prevent a second train when the preceding one has stopped at the platform from moving in so as to be behind the first and only partly at the platform, as a result of the automatic signalling arrangements.

To effect this the home signal in rear of a stopping place will need to show the red marker illuminated whenever a train is in the section of line protected by it (fig. 34).

In addition, owing to the method adopted for dividing up the signalling sections, certain starting signals at the stopping places will not be located at the far ends of the platforms but a certain distance in rear thereof. In this case when such signals are at danger, the yellow drawahead aspect will be lighted up in addition so as to allow of long trains being brought fully into the platform (fig. 35). When the signal is not at danger the ordinary indications (double yellow light or green light) will be shown (fig. 36).

VII. Diagrammatic representation of the new signal on signalling plans.

In order to make it easier to explain the principles adopted in connection with the working of lines under automatic signalling, we propose to deal first of all with the symbols used to designate the new signal on plans and diagrams.

We shall require to understand these likewise in order to explain the arrangement of the locking frames required to be installed in the signal boxes at junctions and large stations.

A *caution or distant signal* will be represented by a circle inside which will be marked the various indications it is capable of giving. The green light will be shown by a small circle, filled in, the two yellow lights by a line drawn at 45 degrees, and the yellow and green lights showing together by a horizontal or vertical line, as the case may require. Finally the combination of the two yellow lights and a green light will be represented by a right-angled triangle filled in.

A few examples of the application of these symbols are given by figures 37 to 39, with those that would be used for the mechanical type signalling as well, to help to make things clear. It is to be noted, however, that the latter symbols are not capable of representing all the indications which can be given by the colour light distant signal, since that signal allows of dealing satisfactorily with certain cases of layout that cannot be treated properly by the mechanical type signalling or the present colour-light signalling (see figs. 40, 48 and 49).

A *stop signal*, whether standing alone or « combined » with another signal, to use an expression current in mechanical signalling work, will be shown by a square in which the various proceed or caution indications will be marked, the stop indication being represented by the square itself.

The « *shunt* » or « *drawahead* » indication is shown by a small horizontal line placed in the lower right hand corner of the square, that of « *taking siding by setting back* » by a vertical arrow, point downwards, placed above the square. Figures 41 to 44 give a few instances of the application of these signs.

The *white marker* is shown by a small circle, not filled in, and the *red one* by a small circle which is filled in. Figure 45 thus represents a stop signal « combined » with other indications in the most complicated form that can arise in practice. There is obviously no way by which this could be shown by the symbols used to denote the existing mechanical type signalling.

Those signals which form bracket signals in intention — *chandeliers fictifs* — are represented in the manner shown by figures 46 and 47. Figure 46 deals with a junction between stations, both branches of which are operated by manually operated interlocked block (lock-and-block). Figure 47 represents the entrance to a large station, track 2 of which has automatic signalling, the starting signals from tracks 1, 2, 3 and 4 being all situated at a sufficient distance ahead of the home signal B to allow of the approach or caution indication being given for them at that signal (a theoretical case taken to facilitate explanation).

The indications denoting the permissible speed are given by the tens figure, marked in the rectangular space corresponding to the route indicated by the illuminated arrow sign. A hatched rectangle denotes that the normal speed of the line may be observed.

By way of example we will again take a case commonly met with of signalling at a through running station, under the present type of colour-light signalling and under the new signalling, both stations being equipped with interlocked block (figs. 48 and 49).

It is to be noted that the doubt which exists regarding the route to be taken and even the speed to be observed, as shown by the indication x given by the distant signal a^1-b in figure 48 disappears in the case of the indications exhibited by the distant signal a-b-c in figure 49 where the indication x is given in three forms (x_1 : stop at signal B; x_2 : diverging route set up towards C and signal C cleared for the train; x_3 : diverging route set towards C and that signal at danger).

N. B. — The routes used by shunt movements have their index figure underlined (see figs. 47 and 49).

VIII. Some of the advantages of the new signalling considered in relation to the existing system.

1) Bracket posts are done away with in every case, resulting in much greater flexibility in arranging and fixing the contact wire structures on lines to be electrified.

2) The signalling apparatus is standardised and the number of items required out on the line is appreciably reduced.

3) The possible fixing of a signal to the contact wire structures, which could not be done in the case of the bracket signals used hitherto, becomes easy of accomplishment where operating conditions permit.

4) The signal lights are brought lower down and their central point to the level of the driver's eye (3.50 m. [11′6″] instead of the present 7 to 10 m. [23′ to 32′9¾″]).

This is a very considerable advantage in foggy weather. In addition, the reduction in area of the proposed background plate compared with bracket post arrangements will ease the problem of making a signal visible between the various contact wire supports sited in front in a curve.

Moreover the fixing of the signals becomes independent of bridges overcrossing the lines since the lights come

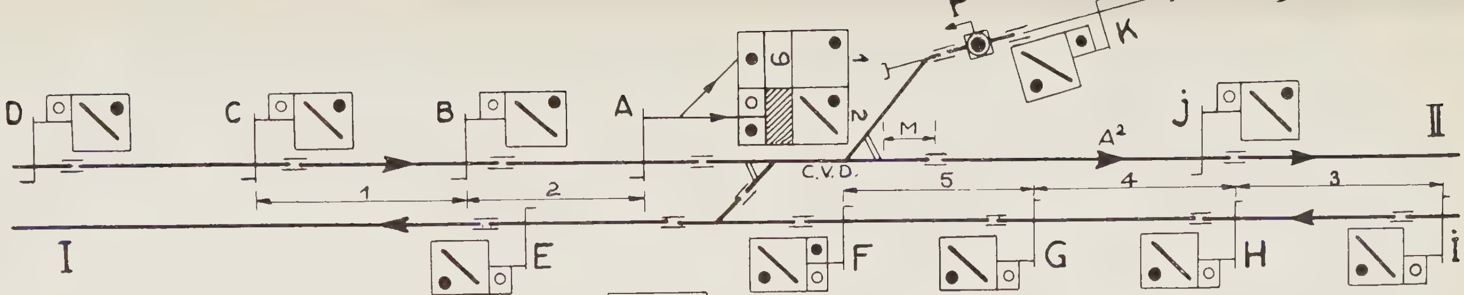

Fig. 52

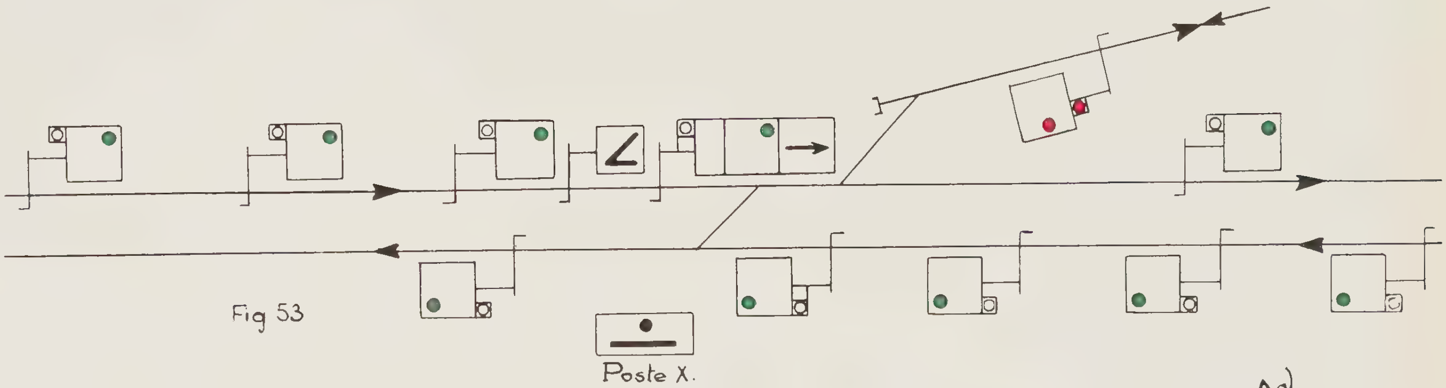

Fig 53

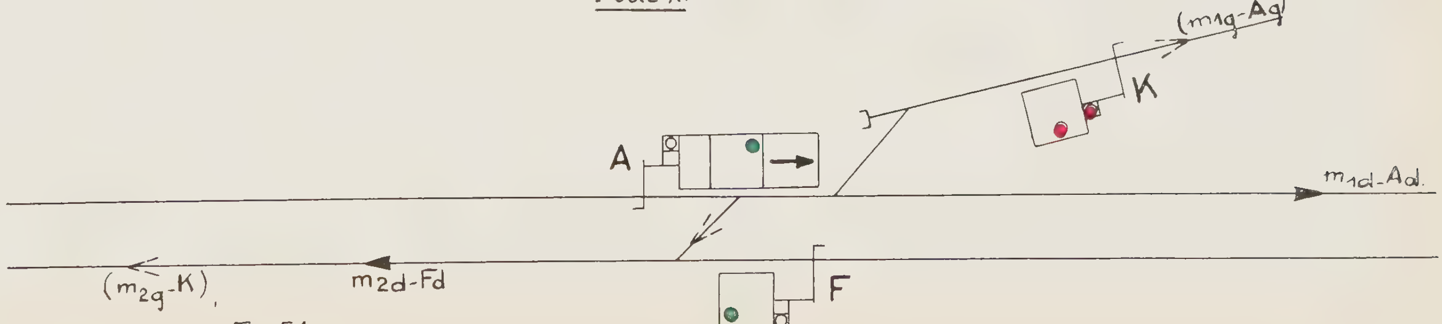

Fig. 54

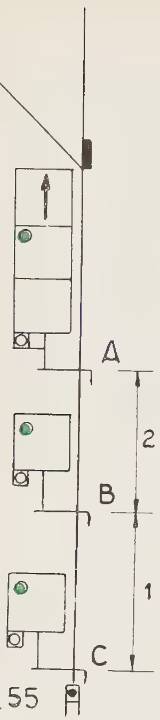

Fig. 55

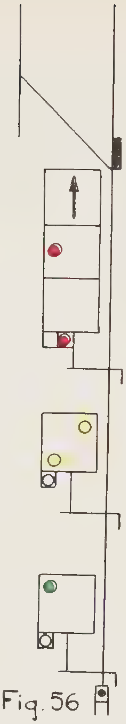
Fig. 56

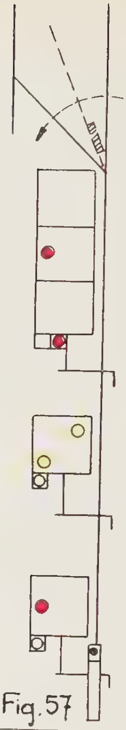
Fig. 57

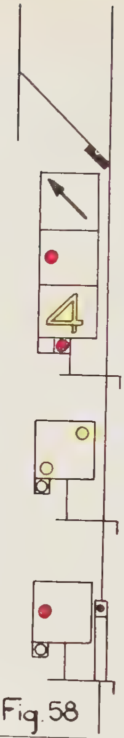

Fig. 58

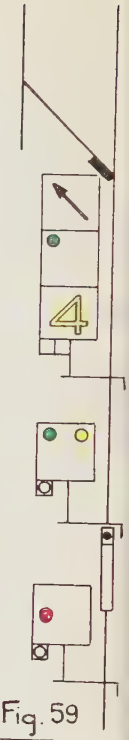

Fig. 59

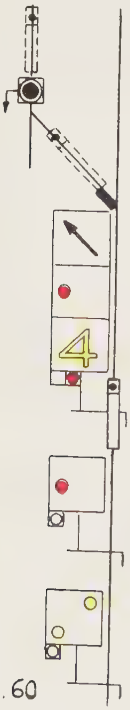

Fig. 60

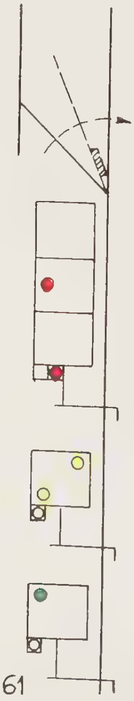
Fig. 61

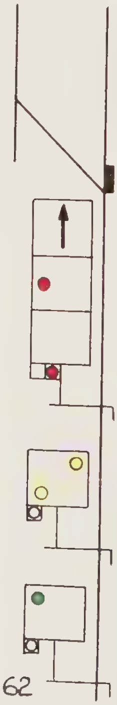
Fig. 62

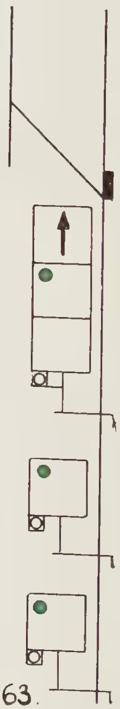
Fig. 63.

below the lower face of the cross-members.

5) Problems incapable of being dealt with under the present signalling can be handled very simply and with complete exactness.

6) The violet light, used as a stop indication for shunt movements, is done away with. It originated from embodying in colour-light signalling the stop indication previously given by the shunt or drawahead arm.

7) The fact of having only a single main red light means that running movements will never need to pass such a light, which they must do with the existing bracket signals. When the proceed indication is given the red light is extinguished and replaced by the green light, or the two yellow lights, or by a combination of them.

8) The uneven indications given by the lighting up of a green aspect on a bracket post colour light signal, the dolls on which are of equal height, are avoided.

At the present time such green light appears necessarily lower down than the red lights on the remaining dolls (figs. 50 and 51). The danger of confusion between the lights on entering or leaving large stations where several bracket posts, gantries or other signals are grouped together, will in this way be very greatly reduced.

N. B. — Similarly, it may be pointed out that confusion between the red and the yellow light, made impossible in the present colour light signalling by doubling the yellow, is also eliminated in the new system.

The arrangement of the two yellow lights at an angle of 45 deg. makes it quite impossible to confuse them with the single red light, or with the main red light showing with the red marker, arranged vertically.

9) A speed of 140 km./h. (87 miles/h.) having been adopted for the main lines, it follows that the length of journey of any particular train will be able to be increased and that the pilot drivers will need to have a knowledge of a much greater number of routes. As the signalling now proposed is much more distinct from the point of view of indicating the various junctions to be met with, the instruction of the pilot drivers will be easier to effect and for the same reason that of the ordinary drivers as well.

PART II.

APPLICATION OF THE NEW SIGNAL TO LINES EQUIPPED WITH AUTOMATIC SIGNALLING.

I. Approach locking and stick control.

In order to make these explanations easier to follow, we will take a concrete example in the form of the junction shown in figure 52.

Let us suppose that the line I-II is to be worked under automatic signalling and that towards III is to have its first section worked by manual interlocked block.

Signals such as A and F controlling the crossing movements will be fitted with white and red markers which will be lighted in accordance with the explanations given below. Signal box X will be of the electro-mechanical type and contain in addition to the levers working the points, both route handles and signal handles.

These handles will be three-position, in order to reduce the size of the apparatus. During such time as only through

trains are running either way between I and II, signals D, C, B, A and J as well as I, H, G, F and E operate entirely automatically and normally show green. In addition, the white marker will be showing at all these signals (fig. 53). At signal K which will be at danger, the red marker will be burning.

In the case of signal A under the conditions we are considering, the route handle m_{1d} will be reversed and also handle A_d, putting the signal to line clear (A).

On signal A the vertical illuminated arrow sign will be showing.

For signal F handle m_{2d} will be reversed locking the corresponding route and handle F_d also, putting the signal F to line clear. Figure 54 shows in schematic form the various routes and the handles referring to them (the references in brackets relate to routes between I and III and inversely).

This being made clear, *let us suppose that a train requires to go from I to III.* Two cases can arise :

1) The train is not preceded by another just in front and has not reached the track circuit sections 1 or 2 (fig. 55). The signalman at box X restores handle A_d to normal, proving through the *approach locking* that there is no train in sections 1 and 2. The main green aspect goes out and the red one lights up. At the same time the white marker is extinguished and the red illuminated (fig. 56). This operation allows of the route handle m_{1d} being restored to normal, extinguishing the vertical arrow sign (fig. 57). The signalman is then free to change the route and set it for III.

The reversal of handles m_{1g} locks this route and illuminates the inclined arrow sign as well as the yellow numeral denoting the permissible speed (fig. 58).

Reversing handle A_g will extinguish the red marker and the main red light and light the green proceed aspect (fig. 59).

As soon as the head of the train passes signal A this will show automatically the main red light and red marker (fig. 60).

When the last vehicle of the train has cleared treadle P which serves to release the block, unlock the route and restore the signal to danger automatically, the signalman at X can re-establish the normal conditions of affairs by going through the movements described in the reverse order (automatical signalling on the main line I-II) (figs. 61 to 63).

2) The train for III is preceded immediately by one going to II. In this case the approach locking prevents the restoration of handle A_d after the passing of such a train, since the train going to III can already have passed signal C and entered on sections 1 and 2. We then make use of the *stick control.* This consists in reversing a rotary switch, the effect of which is, after the train to II has gone by, to cause signal A to show red with red marker. The replacement of handle A_d, which allows of operations similar to those mentioned in 1) above being carried out, is dependent upon the clearing of a track circuit C.V.D., known as *the fouling protection circuit.* This extends over a certain distance M past the points and crossings, with the object of ensuring that should a train standing for any reason beyond the points and protected by signal A at danger with red marker lighted, set back in starting, its rear portion will not come foul of the route towards III (fig. 52).

The stick control therefore cancels the approach locking when this fouling protection track circuit is cleared by the

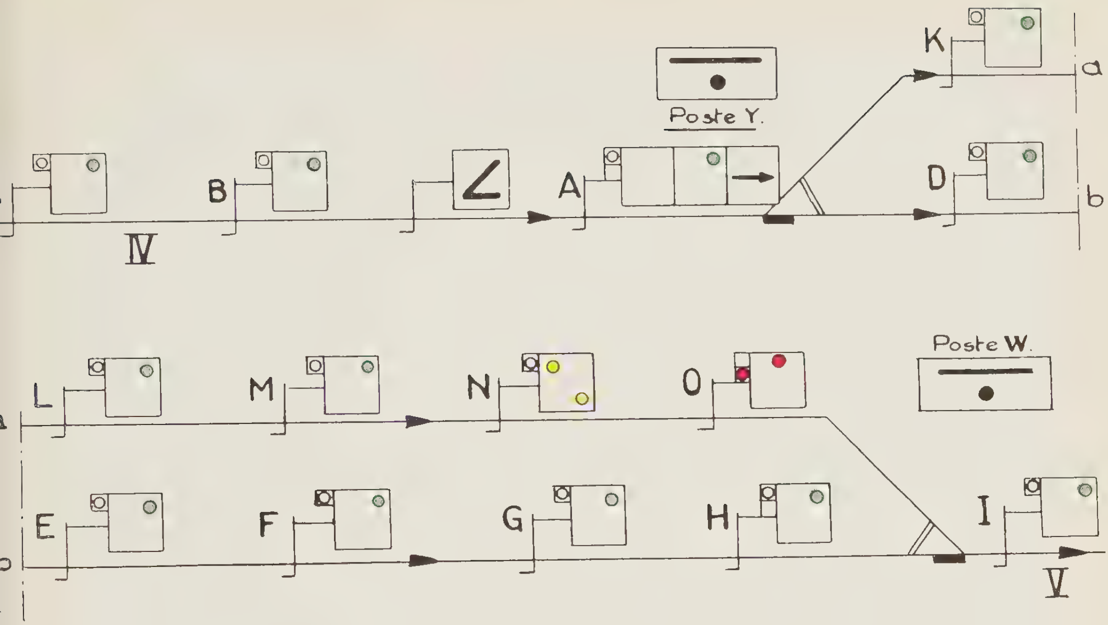

Fig 64

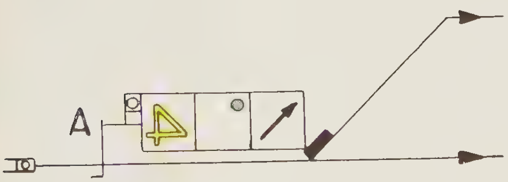

Fig. 65

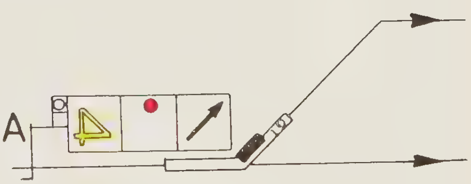

Fig. 66.

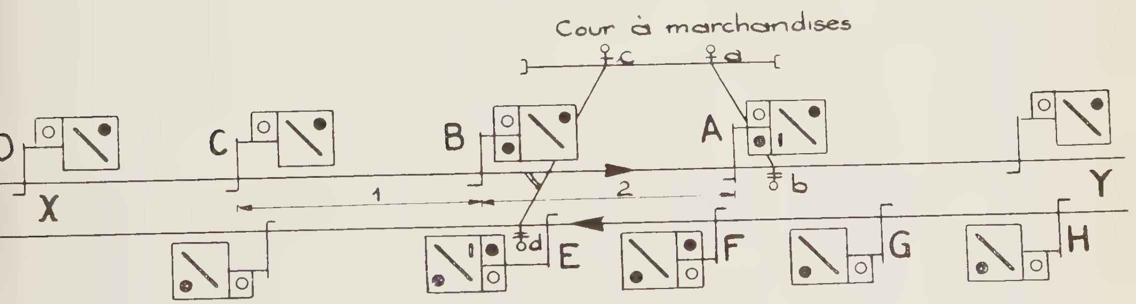

Fig. 67.

Cour à marchandises = Goods yard.

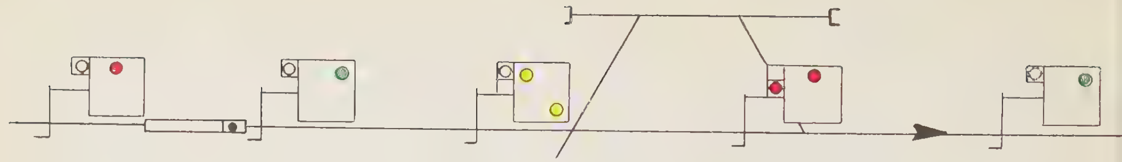

Fig. 68

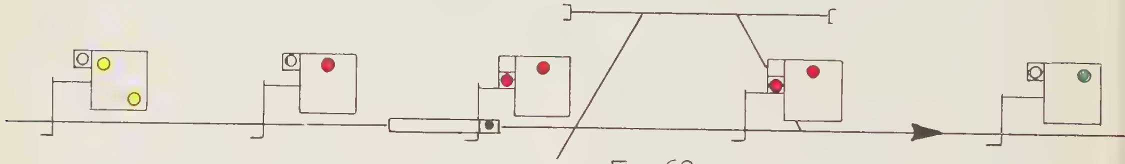

Fig. 69

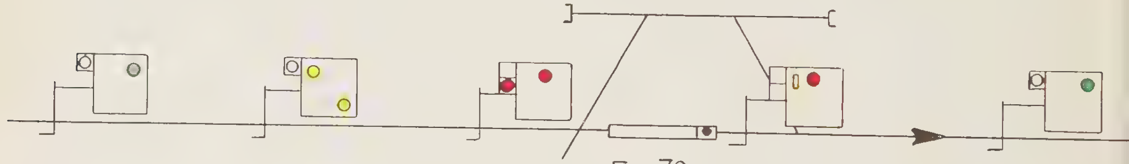

Fig 70

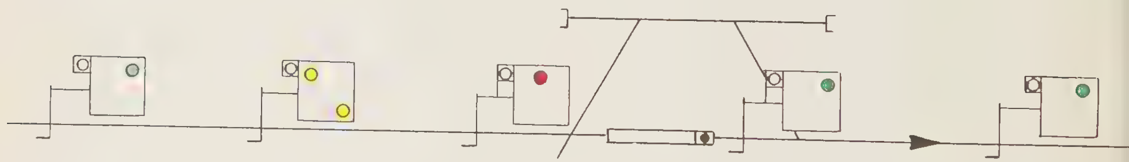

Fig. 71

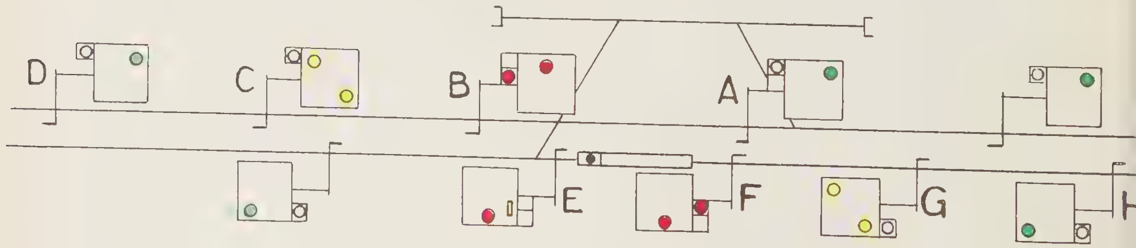

Fig. 72

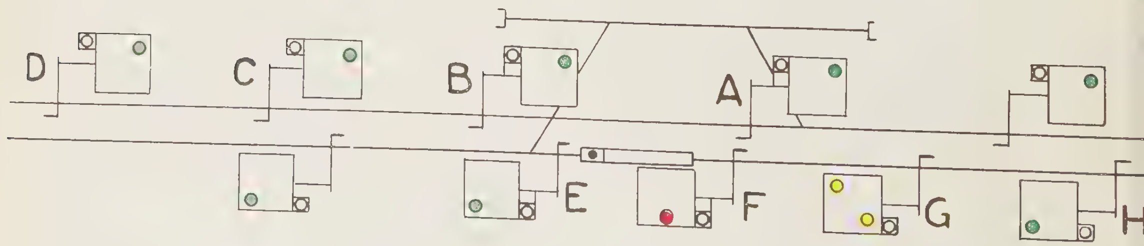

Fig. 73

train and from that moment allows of the replacement of handle A_d. It is to be noted that the clearing of signal A for the route towards III is dependent upon receiving the block release from the first signal box ahead on the line to III and that treadle P will again serve as a block release, route release, and for putting the signal to danger automatically.

The replacement to normal of the rotary stick control switch must be effected before signal A can be cleared for a movement towards line II, that is to say before the reversal of handle A_d.

A train requires to go from III towards I.

In this case in order to clear signal K signals A and F evidently must be put to danger.

To do this use is made of the approach locking or the stick control, according to the situation obtaining at the time as regards trains running between I and II or II and I.

II. Siding line.

Let us now consider the case of movements entering a siding line, as shown in figure 64.

At the controlling signal box Y there will be a 3-position route handle m_1, as at signal box X in the case just dealt with, but the handle controlling signal A will only be 2-position, as both main and siding lines will be equipped with automatic signalling.

All signals in figure 64 will have the white marker permanently illuminated, with the exception of A, H and O, which will show the white or red marker, as explained later.

In the case of trains running from IV towards V on the main line all the signals C, B, A, D, E, F, G, H and I will exhibit the same indications as similar signals at the junction shown in figure 52.

If there is no train on the siding line signals K, L, M, N and O will show indications as given in figure 64.

When a train requires to be directed to the siding line the signalman at Y will set up the route by using the approach or the stick control, as in the preceding case. However, since there is automatic signalling on the siding line no release has to be obtained from the signal box in advance. If therefore the first section on the siding line is unoccupied signal A will exhibit the indications shown in figure 65.

It should be noted that the white marker is burning, since there is automatic signalling on both lines, provided of course that *one or other* of the two routes is set, proved and locked by handles m_{1g} or m_{1d}.

Two cases can now arise, according to whether the first train directed to the siding line is or is not followed by a second going to the same line.

1) If the second train also is to go to that line the signalman has nothing to do and everything takes place exactly as with movements along the main line, while the same applies if the following trains also have to take that line. After the first train has passed signal A we have the situation shown in figure 66 and the change in the signal aspects will take place automatically.

2) If the second train is not to travel to the siding line, the signalman has again to intervene through the approach or stick controls. Operations the reverse of those described at the beginning of this paragraph will establish the normal condition with route set up for the direct movement IV to V.

At the outlet signal box W, be it noted,

operations similar to those effected at box Y will bring trains from the siding line to the main line (approach and stick control).

III. Shunting movements in station limits or from goods yards.

The operation of points giving access to goods yards will in general be effected locally, the keys of the key-locks being interlocked either directly on the lever frame itself, or indirectly by means of electrical release equipment.

In those instances where the points in question require to be operated mechanically or electrically from the central frame the interlocking will evidently be carried out directly thereon. This being explained, we may consider the case shown in figure 67 where signals A and E are able to show the shunt aspect.

First case.

When a train from X to Y has to carry out shunting movements, we have first of all to cancel the automatic working of signal A, proving through the approach control that sections 1 and 2 are unoccupied, or else by using the stick control for signal A after the passing of the train preceding that requiring to shunt.

We thus shall have produced the situation shown in figure 68, signal A having been put to red with red marker burning.

Putting signal A to danger, however, will have brought into action the stick control on signal B which will go to danger automatically, with red marker showing, as soon as the first axle of the train requiring to shunt passes it (fig. 69).

Signal B indeed cannot be left at danger with the white marker showing since if the shunting train were to set back in starting it might collide with one which had entered section 2 at caution.

Immediately after signal B has been put to danger with red marker burning, the signalman is able to reverse the handle which lights up the shunt aspect on that signal (fig. 70). This will have the result of releasing either the keys for points *a* and *b* or the levers or handles which operate them from the signal box.

When the shunting movements are completed and points *a* and *b* have been relocked in the correct position, the automatic working of signals A and B is restored and the position seen in figure 71 established. The train may then proceed on its way.

Second case.

When a train going from Y to X has to carry out shunting movements, it becomes necessary to effect for signals E and F the same operations as those performed in connection with signals A and B in our first case above.

However, in addition to that, signal B requires to be put to danger with red marker showing (after going through the approach or stick control proving). The consequence is that at the moment when the keys or levers of points *c* and *d* are released, the lights appearing in the signals will be as shown in figure 72.

When shunting is finished and points *c* and *d* again locked normal the signals will appear as in figure 73. The train may then leave and automatic working will be once more in operation on both tracks.

IV. Train taking siding by setting back.

From the point of view of the protection afforded by the signals in rear, movements made into sidings by setting back are effected under exactly the same conditions as ordinary shunting operations.

Brussels, 6th August 1948.

[625 .173 (.44)]

Intensive track renewal work,

by

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(*Revue Générale des Chemins de fer, September 1947.*)

1) *Task.* — Owing to the considerable deferment of renewal work since 1939, track ages have greatly increased and there is a lack of serviceable rails of various lengths and types for the spot replacement of rails in main lines which are found to be defective. The section of the Paris-Bordeaux line between Orleans and Tours, which was scheduled for renewal, provided an opportunity for recovering rails of S.12 and S.33 types of 16.51 m. (54′2¹/₁₆″) and 22.014 m. (72′2⁴³/₆₄″).

The new rails laid were of U.33 type, 46 kgr. (101.413 lbs.) 18 m. (59′⁵/₈″).

The length of track to be renewed was 38 km. (29.82 miles).

2) *Outline of the work required.* — Briefly, this was the replacement of the rails by others having the same width of foot (the width of foot of U.33 is the same as that of the S.33 and S.12, which allows the sleepers to be retained), but the length of the new rails was 18 m. and that of the old rails 16.51 m. or 22.014 m., so that it was necessary to re-site practically all the sleepers. It was logical, therefore, at the same time to replace the worst of the sleepers.

Finally, to provide a satisfactory bed for the track, it was necessary to break up the old casts.

The track had for many years been maintained by measured shovel packing

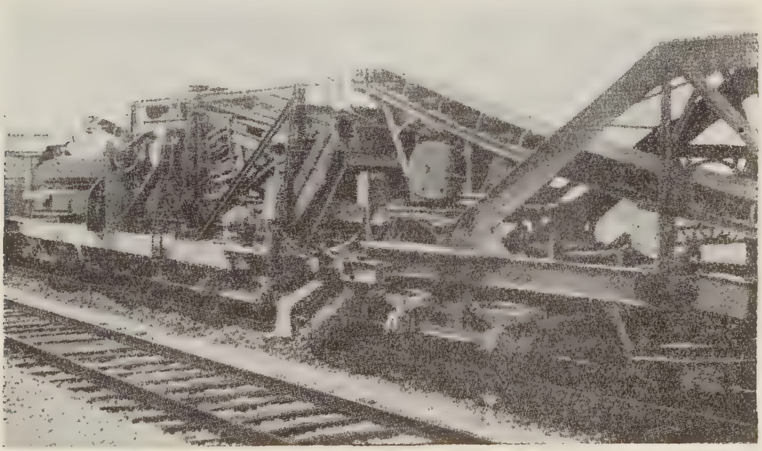


Fig. 1. — S.E.C.O. track stripper; channels pouring out ballast and broken stone alongside the track.

and it was advantageous to recover the broken stone from under the sleepers (recovery was in the region of 90 tons per kilometre). The ballast was of good quality and of satisfactory depth, which avoided the necessity of bringing fresh ballast to the site.

3) *Necessity for rapid work.* — We were in urgent need of rails for spot replacement: moreover, the Operating Department was insistent that the work should be completed before the 4th May, 1947, when a new timetable was to come into operation.

The order to roll the rails was given to the mills on the 20th January, 1947. The first rails arrived on the site on the 5th February.

Tenders were invited on the 28th January, accepted on the 18th February and work commenced on the 28th February.

To complete the work by early May, and taking into account the time lost through stations, the coverage had to be 800/1 000 m. (880/1 070 yards) per day.

4) *Organisation of the work.* — The sequence of operations was as follows:—

a) Clearance of 0.05 m. (2″) under sleepers by the use of the S.E.C.O. track stripper, which moved the screened ballast laterally, separated the stone and deposited it at intervals alongside the track (fig. 1).

This machine comprised a long underframe on 2 bogies set 28 m. (91′10$^3/_8$″) apart. An excavator in the centre of the frame extracted the ballast from under the sleepers and conveyed it to a hopper.

Fig. 2. — Replacement of sleepers under the stripper.

To allow this excavator to operate, the track was raised by an adjustable device which permitted the regulation of the depth of stripping.

b) The lifting of the track thus achieved was utilised for removing the sleepers, from which the coachscrews had previously been withdrawn, between the leading bogie and the excavator, and subsequently for inserting the replace sleepers between the excavator and the rear bogie (fig. 2).

Mechanical screwdrivers removed the

outer coachscrews and loosened the inner ones (fig. 3).

c) New rails were laid on the sleepers alongside their position on the track.

d) Old rails were removed and new rails placed in position.

e) The old rails were loaded on the trucks which had brought the new ones (fig. 4).

Fig. 3. — Mechanical coachscrew drivers.

f) The sleepers were set in their final position, the rails being marked for this purpose. This work was facilitated by a slight lifting of the rails by means of jacks.

g) The coachscrews were screwed down.

h) The ballast previously set aside was replaced in the track.

i) The track was levelled in front of the tamper; one sleeper was inserted every 4.50 m. (14′9³/₁₆″).

j) Mechanically tamped (fig. 5).

k) Ballast aligned and cleaned up.

5) *Equipment used:*

— 1 S.E.C.O. mechanical ballast stripper, specially equipped for the work.

— 2 60 H.P. trolleys.

— 12 rakes of rail and sleeper wagons.

— 8 mechanical coachscrew drivers.

— 1 Scheuchzer mechanical tamper.

— Hoists for use at stations in loading recovered rails.

6) *Personnel employed:*

	S.N.C.F.	Contractor.
Supervision, protection of personnel, assistance in various movements	29	
Setting of sleepers to the right of the track stripper	10	
Operation of track stripper		6
Replacement and refixing of rails		60
Refilling track before tamping		25
Levelling before tamping; dressing and cleaning up . . .		36
Mechanical tamper . .		3
Handling in stations .		20
Restoration of electrical connections .	4	
Signal work	7	
Laying and removal of single-line apparatus, catenary work, etc. .	20	20
Finishing off		30
Totals . .	70	200
	270	

7) *Operating problems.* — The temporary single-line service was organised in successive stages, each covering two consecutive stations.

Entry to single-line sections was arranged by laying switches at required places.

Signalling normally effected by illuminated automatic block was replaced by temporary signals, which were cut out during normal working and locked with Bouré locks. The period of single-

Fig. 4. — Train of new rails.

Fig. 5. — « Matisa » tamper.

line working was for 7½ hours (8 a.m. to 3.30 p.m.). On resumption of normal double-track working, speed was restricted to 30 km./h. (18 m.p.h.) over the section renewed during the day, or, say 1 200 m. (1 312 yards). Normal speeds of 120 km./h. (74 m.p.h.) were worked over the section renewed the previous day.

The speed of wrong-line running on the temporary single-line section was restricted to 70 km./h. (43 m.p.h.), whilst the passage of the entrance to and exit from the single-line section was limited to 30 km./h. (18 m.p.h.).

8) *Results achieved.* — Allowing for the time taken in getting the equipment on the road, which took place during very bad weather, and for the arrangements in connection with the successive stages, the average daily rate of progress was 1 080 m. (1 180 yards); the highest daily rate was 1 460 m. (1 596 yards).

[621 .337]

Individual axle drive.

Mechanical systems used on electric locomotives and railcars, with an indication of the results obtained in service on railways of all kinds,

(Continued)*

by ADOLPHE-M. HUG,

Consulting Engineer, of Thalwil, (Zurich) Switzerland.

Chapter VII.

RACK RAILWAYS

(with some notes on tramways).

Rack railways may be sub-divided into railways wholly rack-operated, and railways operated partly by rack and partly by adhesion ([155]).

In the former case only the rack pinions are driven from the motor or motors (according to the type), the wheels running on the rails being for carrying purposes only, and in view of the low speed, they may be of very small diameter. The latter are provided with a set (or part-set) of driving wheels, for the adhesion sections, and a rack-pinion for the rack-section. Sometimes the same motors are used, for both rack and adhesion sections, in the locomotive or railcar. This is particularly the case when the pinion is mounted on a driving axle (see fig. 273). This arrangement has already been dealt with in **Cde. indiv.**, in connection with the electric locomotives of the Viege-Zermatt railway ([156]).

Within the scope of an article on individual axle drive, rack railways have only a relative part in so far as electric, or internal combustion, motors are used for traction, and they will therefore be dealt with briefly; general remarks, and some recent examples of railcars and electric locomotives, will be given.

The first rack railways had their origin towards the end of the last century; those which were electrified from their inception worked on 600-800 V., 3-phase (e.g. Gornergrat, see fig. 268, Stansstad-Engelberg, Jungfrau — all in Switzerland). There are examples of rack railways in various continents (e.g.

(*) See *Bulletin of the International Railway Congress Association*, Nos. of September, October and December 1947, pp. 823, 885 and 999 respectively, Nos. of February, April, July, October and November 1948, pp. 73, 227, 403, 591 and 661 respectively.

([155]) For general and historical bibliography concerning rack railways, see *20 000 Schriftquellen zur Eisenbahnkunde* by K. EWALD, published by Henschel, Kassel, section Z, pp. 895 and 896.

([156]) See **Cde. indiv.**, Chapter VI, pp. 98-99 and bibliography, p. 99.

the Transandes, connecting the Argentine and Chili; Beyrouth-Damas; the Swiss Brünig — see figs. 274 and 275).

The majority of rack railways are in Switzerland, about thirty ([157]), and with the exception of two, are all electric or have been electrified; the track gauge varies between 800 mm. (2′7½″) and standard gauge; 13 of the railways are rack throughout and the remainder part-rack and part-adhesion. There are four main rack systems, viz. Abt (the most extensive), Strub; Riggerbach (or ladder-rack) and Locher, the latter being a double rack with dual drive for steep gradients (see fig. 263). Most rack systems have gradients of 110 to 250 per mille in the case of the first three systems, and up to 480 per mille for the Locher system (Pilate Railway, near Lucerne, Switzerland, see fig. 262).

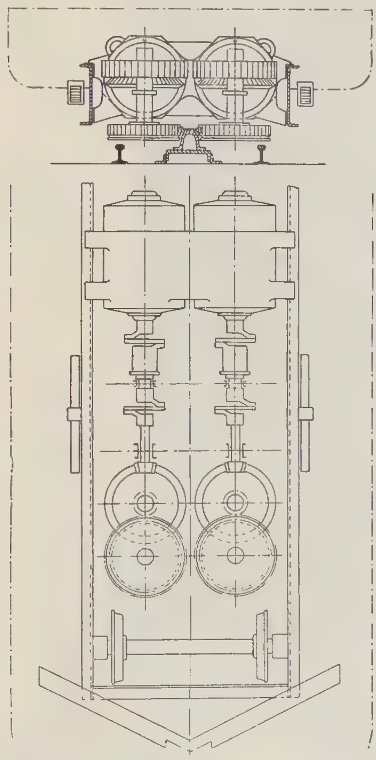
The running *speed*, and consequently the carrying capacity of rack railways, is low, particularly with steam traction where speeds scarcely ever exceed 8-10 km./h. (5.6 m.p.h.). With electric railcars of modern construction, 25 km./h. (15½ m.p.h.) ascending, and 18-22 km./h. (11-14 m.p.h.) descending, are attained.

Cliché Oerlikon.

Fig. 262. — Electric rack railcar of the Pilatus Railway (Switzerland). The view is from an angle which makes the gradient appear less severe.

([157]) See *Bulletin Technique SLM*, Winterthur, April 1941, pp. 9-17.

Where the wheels on the rails are exclusively carrying, and adhesion has no part to play, the rack being continuous (fig. 271 is a typical example), transmission is usually through double reduction direct gears, with flexible or sliding components interposed. This is a fairly simple arrangement and is clearly shown in figure 4, page 775 of the publication



Cliché Oerlikon.

Fig. 263. — Plan and elevation of driving mechanism on car shown in fig. 262. Twin motor carried on the main frame and coupled through double cardan joints. It will be noted that the carrying wheels have flanges outside the rails. *(Patent SLM.)*

mentioned in note ([164]). In the beginning, most rack locomotives were built in this way.

Where the adhesive driving axle also carries the rack pinion, the motor works on two series of gears, as described on page 100 of **Cde. indiv.** ([156]).

Finally, modern railcars generally have the arrangement shown diagrammatically in figure 267.

It may be mentioned that all rack railway motor vehicles in Switzerland, and many in other countries (India, the Andes, Syria, Indo-China, etc.), steam, electric or internal combustion, have been built, so far as the mechanical and motion parts are concerned, by SLM, Winterthur.

The following notes deal with some noteworthy modern Swiss operations :—

Light railcars.

a) The Pilate *(Pilatusbahn)* Railway ([158]), has already been noted as containing the steepest gradient in the world (48 %) for a non-cable railway. This line began operating in 1888 with steam traction, and was electrified in 1936-37. Figure 262 shows a railcar on the line and figure 263 the arrangement of the driving mechanism.

The modernisation of this railway, both as regards electrification and improvements in the railway installation generally, has reduced the time for the throughout journey of 4.7 km. (2.92 miles) with a change in altitude of more than 1 500 m. (1 640 yards), from 78 to 28 minutes, which has more than doubled its capacity. The gauge is 800 mm., the hourly rating of the twin

([158]) See *Bulletin Oerlikon*, Zurich, Nos. 183-184, 1936, pp. 981-982, and 193-194, 1937, p. 1026. — *Bulletin Technique SLM*, Winterthur, April 1941, pp. 13 and 16.

motors of the cars is 210 H.P., maximum speed 12.5 km./h. (7½ m.p.h.), tare 9.7 tons, total loaded weight about 12.7 tons. Oerlikon electrical equipment is used.

The electrification and modernisation of other rack railways has provided, as a result of fast railcars, results which are equally favourable [159].

b) The local electric railway, *Bex-Villars-Bretaye*, BVB (formerly the Bex-Gruyon-Villars-Chesières, BGVC), 650 V. DC, combined rack and adhesion, placed in service in 1939-40, a first series of 3 electric railcars, 250 H.P. hourly rating,

Cliché Oerlikon.

Fig. 264. — Electric railcar of the Bex-Villars-Bretaye (B.G.V.C.) Railway on rack section running into Gryon.

maximum speed 30 km./h. (18 m.p.h.) adhesive, 18 km./h. (11 m.p.h.) on rack sections ascending, and 14-15 km./h. (8½-9 m.p.h.) on rack sections descending [159] [160].

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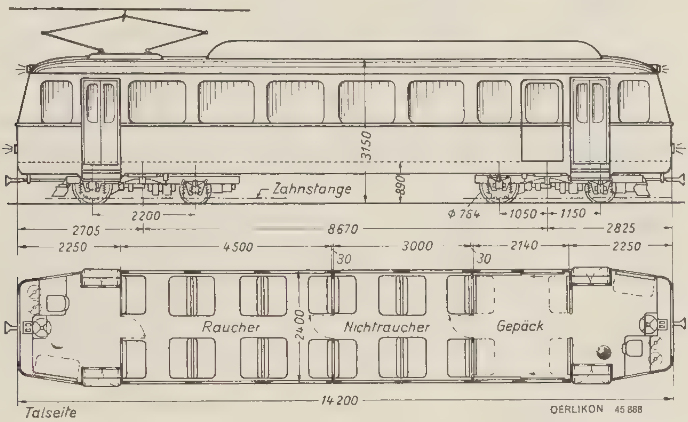
(159) See *Bulletin Technique SLM*, Winterthur, April 1941, pp. 15 and 16; Dec. 1942, pp. 24-46, and Summer, 1948, pp. 3-13. — *Economie et Technique des Transports*, Lucerne, 1940-41, pp. 17-20, « Augmentation de la capacité de chemins de fer de montagne », by Ad.-M. HUG.

(160) See *Bulletin Oerlikon*, Zurich, No. 227, 1940, pp. 1393-1398, 11 figs.

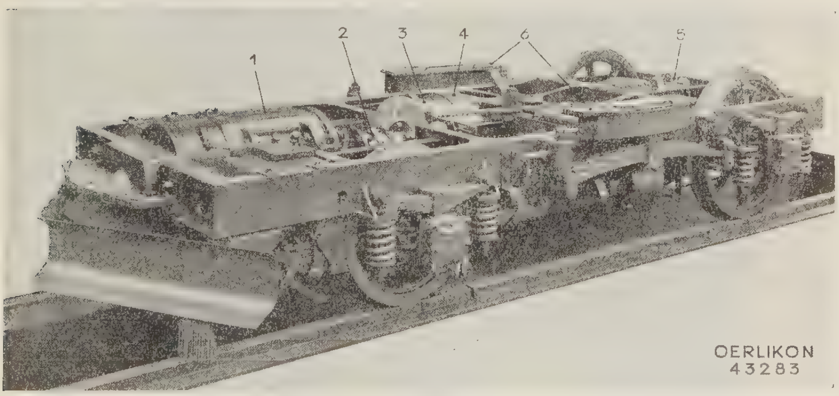
On metre gauge track, the cars have two bogies the outer axle of each driving. Figures 264-267 show the railcar, the carrying/driving bogie and the driving mechanism. Electrical equipment is Oerlikon.

c) The *Gornergrat* Railway, on the Zermatt, Switzerland, GGB, which cele-



Cliché Oerlikon.

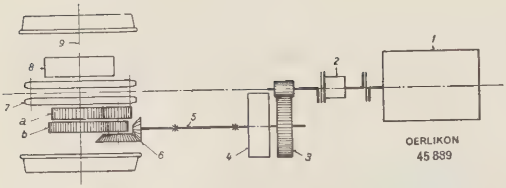
Fig. 265. — Dimensioned sketch of railcar in fig. 264, front end on left. (Zahnstange = rack; Gepack = luggage compartment.)



Cliché Oerlikon.

Fig. 266. — Upper driving-carrying bogie of cars in figs. 264 and 265.

1 = motor with centrifugal circuit-breaker.
2 = flexible coupling.
3 = reducing gear.
4 = drum of band brake.
5 = rack driving pinion.
6 = lateral body bearing blocks.



Cliché Oerlikon.

Fig. 267. — Diagram of driving mechanism of railcars in figs. 264-266 (see also 268 and 269).

1-4 = as fig. 266.
5 = cardan shaft.
6 = conical gear.
7 = rack pinion (Abt system — 2 parts).
8 = brake drum with band and blocks.
9 = driving axle.
a = direct gear drive for rack.
b = direct gear drive for adhesion.

brated its 50th anniversary in August, 1948, and is electrically operated, put into service, in 1946-47, two railcars, series 101, type Che $^2/_4$, as shown in figure 268. The electrical supply is 3-phase, 750 V., 50 cycles. These cars have a high capacity, as in view of the almost constant gradient of 200 per mille the floor of the car is stepped, and taking into account the standing room they have a capacity of up to 110 passengers. In winter, they haul 2-axled light trailers up the moutain side for transport of skis. The gauge is one metre ([161]).

The bogies of the railcars are arranged similarly to those in figures 265-267 and 269. Electrical equipment is by Brown Boveri.

d) The *Aigle-Leysin*, AL, Railway,

SLM.

Fig. 268. — 3-phase rack railcar, high-capacity, 1946, Gornergrat (GGB), Switzerland. Left is Mont-Cervin, 4 505 m. (14 760′).

([161]) See *Bulletin Technique SLM*, Winterthur, Summer No. 1948, pp. 5-8. 6 figs. — *Revue Brown Boveri*, Baden, Nos. 10-11, 1945, pp. 403-404.

Switzerland, combined rack and adhesion, placed in service in 1946, 3 electric railcars (162), type BCFhe$^{2}/_{4}$, Nos. 201-203, 1 300 V. DC, metre gauge. These railcars, figure 269, are similar to those described under *b*). Electrical equipment is by Brown Boveri.

e) The *Wengernalp* Railway, WAB, Switzerland, which connects the Bernese Oberland (BOB) from Interlaken to Grindelwald and Lauterbrunen, to the Jungfrau rack railway (the mountain, Jungfraujoch, station of which is 3 450 m. [11 319′] altitude), 800 mm.

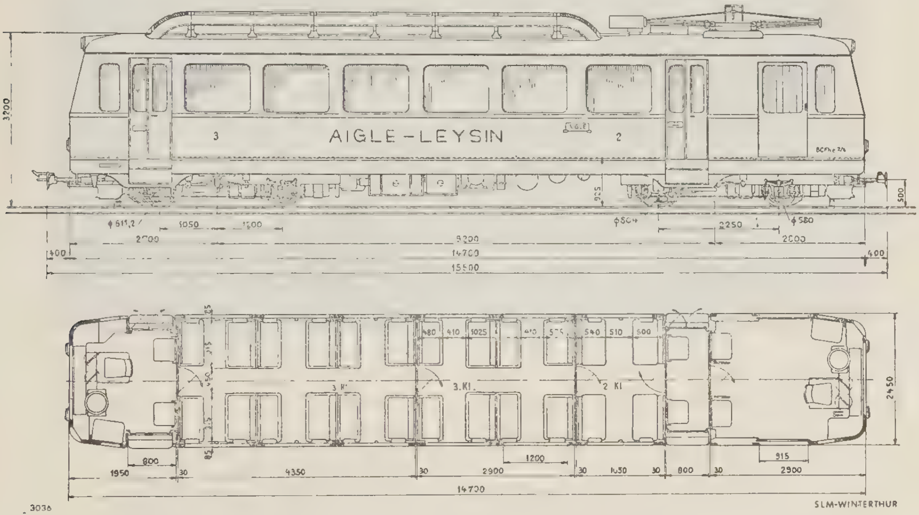


Fig. 269. — 1946 electric railcar, for combined rack and adhesion, Aigle-Leysin, Switzerland. (Cf. figs. 264-267.)

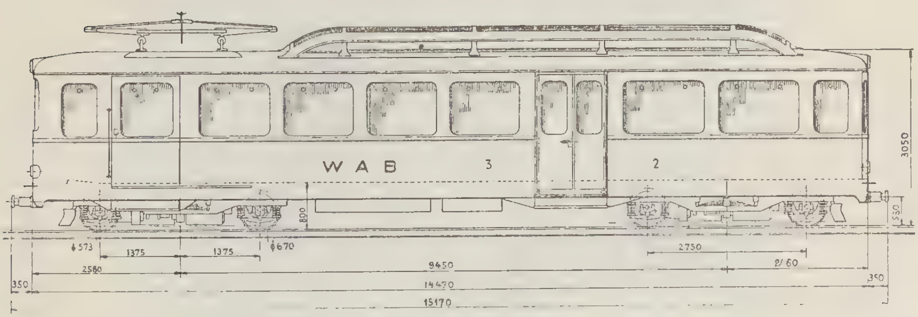
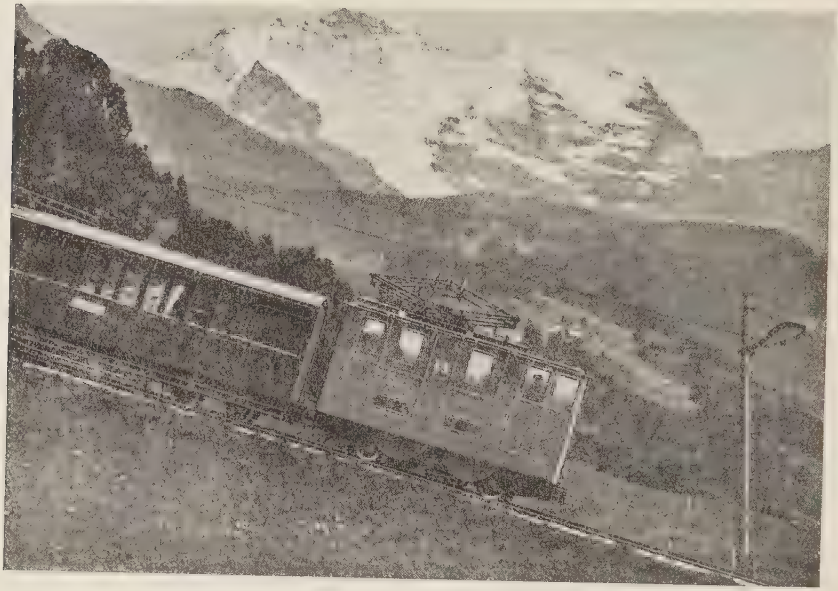


Fig. 270. — 1947-48 electric railcar of Wengernalp (Bernese Oberland) Railway. 2 bogies, each with 2 motors. 1 500 V. DC, 800 mm. gauge.

(162) See publications mentioned in note (161), but pp. 3-5 and 402-403 respectively. — See also *Revue Brown Boveri*, pp. 92-94, E. Hugentobler.

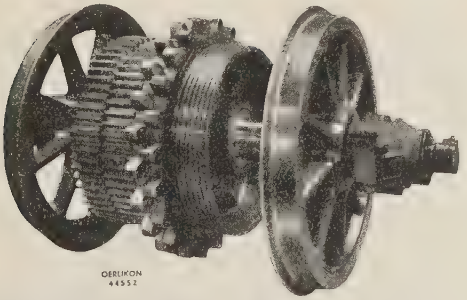


Cliché Oerlikon.

Fig. 271. — 1928 electric rack locomotive, Wengernalp Rly. (same system as fig. 270) on a 250 per mille gradient. In the background is the Jungfrau, 4 167 m. (13 670′).

Cliché Oerlikon.

Fig. 272. — B_0-B_0 electric locomotive for combined rack and adhesion; Furka-Oberalp (F.O.) Rly., Switzerland.



Cliché Oerlikon.

Fig. 273. — Driving axle of locomotive in fig. 272 (2 similar axles for bogie). *(Construction SLM.)*

(2′7½″) gauge, 1 500 V. DC, put into service in 1947-48, three railcars to the diagram shown in figure 270, type BCFhe$^2/_4$, with 2 driving bogies each with 2 motors ([163]). This railway operates on the rack system throughout (Riggenbach system) with gradients of up to 250 per mille. The hourly rating of the 4 motors is 520 H.P. and maximum speed is 25 km./h. (15½ m.p.h.). Electrical equipment is by Brown Boveri.

Locomotives.

f) The WAB Railway mentioned under *e*) put into service in 1929 a locomotive of a most recent type with two rack wheels, each driven by one motor, and two carrying axles. Figure 271 shows this locomotive, which has an hourly rating at the geared rim of 340 H.P.; its speeds are 8.5 km./h. (5 m.p.h.) ascending and 10-11 km./h. (6.2-6.8 m.p.h.) descending. This, therefore, points to the great progress realised 10 to 15 years later when new railcars are operating at almost three times the speed. This locomotive (Oerlikon, 1928, electrical equipment) ([164]) is described here purely to

Cliché Oerlikon.

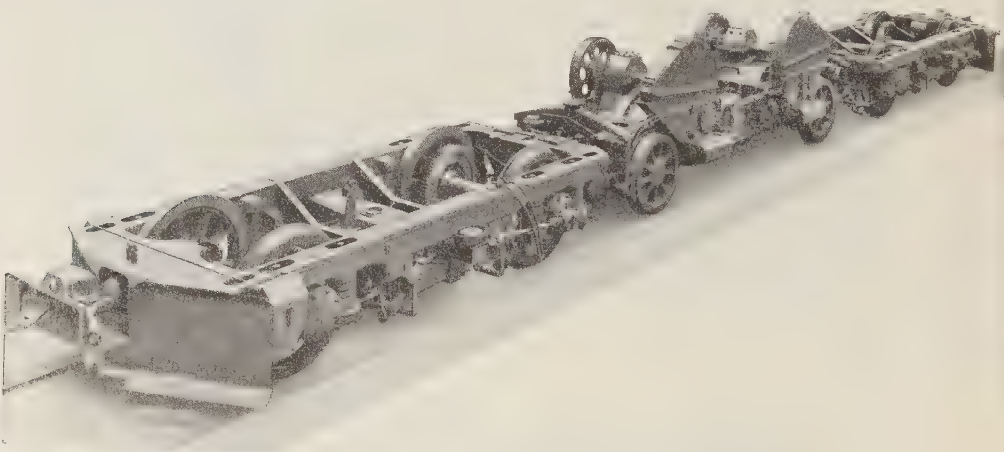
Fig. 274. — Single-phase electric locomotive for combined rack and adhesion, Brünig line, Swiss Federal.

([163]) See publications mentioned in note ([161]), but pp. 8-10 and 402-404 respectively.

([164]) See *Bulletin Oerlikon*, Zurich, No. 142, April 1933, pp. 774-776.

provide a standard of comparison for the same Company's railcar noted under item *e*) ([165]).

g) The electric locomotives of the *Furka-Oberalp* (F.O.) Railway, a metre-gauge line of 97 km. (60 miles) length, connecting Brigue (Rhone Valley and Simplon tunnel) with Grisons in Eastern modern than, the previous ones, 1928, of the Viege-Zermatt, VZ, railway ([155]). The F.O. also operates on 11 kV., single-phase, $16^2/_3$ cycles. The locomotives weigh 46 tons and can haul a train load of 100 tons on a gradient of 110 per mille at a speed of 27 km./h. (16 m.p.h.) : maximum speed is 55 km./h. (34 m.p.h.) adhesive and 30 km./h. (18 m.p.h.) on



Cliché Oerlikon.

Fig. 275. — Set of wheels for locomotive in fig. 274. In the centre, driving bogie for rack working; at the ends, the two adhesion driving bogies. *(Construction SLM.)*

Switzerland (crossing over the St. Gothard tunnel), are amongst the most powerful machines used for combined rack and adhesion, as they have an hourly rating of 1 400 H.P. ([166]). The locomotives are type $HGe^4/_4$, B_0B_0, Nos. 31 to 35, and are similar to, although more rack working. Electrical equipment is by Oerlikon.

The F.O. Railway also possesses five railcars, type $BCFhe^2/_4$, Nos. 41-45, weight 35 tons, hourly rating about 600 H.P. Brown Boveri ([167]) and Secheron electrical equipment is used.

([165]) A complete rationalisation of the 3 systems mentioned at the beginning of *e*) is not possible because of the different gauges. Leaving Interlaken, (BLS standard gauge), the BOB is metre gauge, the WAB is 800 mm. and, highest of all, the Jungfrau line, standard gauge.

([166]) See *Bulletin Oerlikon*, Zurich, Special International Railway Congress, 1947, number, pp. 12-15 and 234-235, Nov. 1941 and Feb. 1942, respectively; « Electric locomotives of the Furka-Oberalp and railcars of the Brünig Railways » (in German), 14 p., 17 figs, tables and plans, C. BODNER. — *Bulletin Technique SLM*, Winterthur, Nov. 1941, pp. 26-27.

([167]) *Revue Brown Boveri*, Baden, no. 10/11, pp. 399-400. — *Bulletin Sécheron*, Geneva, No. 14, 1942, pp. 5-6.

h) To conclude this Chapter, a brief mention may be made of the combined rack/adhesion locomotives of the Brünig Railway in Switzerland; the length is 73 km. (45 miles), 9 km. (5½ miles) of which is rack, and the system connects Lucerne with Interlaken via the Brünig pass (1 005 m. [3 296′] altitude) and Meiringen. This is a metre gauge line which was embodied in the Swiss National system (SBB-CFF) and later electrified for 15 kV. single-phase, $16^2/_3$ cycles.

In 1941-42, 16 motor vans were put into service on this line to work as locomotives; they were type $Fhe^4/_6$, Nos. 901-916 ([168]). At the time of the electrification the management were in course of introducing on this line automatic couplings +GF+ ([169]) and this has also contributed to more efficient working. The rack is arranged on the Riggenbach system.

The locomotives are shown in figures 274 and 275; they have an hourly rating of 1 250 H.P. adhesive (maximum speed, 75 km./h. [46 m.p.h.]) and 685 H.P. on rack working (maximum speed 25 km./h. [15 m.p.h.] on 120 per mille gradient). The two outer bogies (adhesive) are fitted with nose-suspended motors. The central bogie, for rack working, has two superelevated motors, each driving one of the rack pinions through double reduction gears and the usual transmission arrangements. Electrical equipment is by the three firms, Brown Boveri, Oerlikon and Secheron-Geneva.

It may be added, in connection with these locomotives, that the adhesion bogies are also driven during rack section working, but the tension of the motors is reduced. the 4 armatures being coupled in series, instead of the normal coupling in series in pairs.

Most rack motor vehicles run on down-gradients with electric resistance braking, the current-collector being lowered and the vehicles being therefore free of the live wire.

As regards tramways, mention was made in the column over figure 12 of the advantages offered by fully suspended motors. Furthermore, in Chapter VI we dealt with a large number of tramway vehicles with flexible suspension arrangements and as further examples will be given in the Appendix, we shall mention here, purely as a reminder, the large-scale use in the U.S.A., particularly on P.C.C. type vehicles ([170]). Similar devices are used on a certain number of new cars of the Stockholm Tramways (Stockholms Spårvägar, SS), built by the Hägglund Works, Ornsköldsvik (Sweden). The motors are arranged sometimes parallel to the axle, sometimes at right angles to the axle (parallel to the longitudinal axis of the vehicle); regarding this, please see the descriptions concerning figures 185-187 of Cde. indiv., with or without worm gear.

(To be continued.)

([168]) See *CFF Bulletin*, Berne, No. 12, 1941, pp. 196-199, 6 figs. and tables, F. STEINER. — *Bulletin Technique SLM*, Winterthur, April 1941, pp. 11-13, and Nov. 1941, pp. 27-28. — *Bulletin Oerlikon*, Zurich, International Railway Congress, 1947, number, (265-266), pp. 14-15. See also note ([166]). — *Bulletin Sécheron*, Geneva, No. 14, 1942, pp. 2-4.

([169]) See *CFF Bulletin*, Berne, No. 7, 1941. — With reference to use on rack section, see *Bulletin Technique SLM*, Winterthur, Dec. 1942, pp. 18-19.

([170]) See *Revue de l'Association Française des Amis des Chemins de fer*, No. 142, 1947, fig. 5, p. 10. — *Verkehrstechnik*, Berlin, 20/5/41, pp. 145-146, and 12/5/40, pp. 176-177.

[385 (06 .111]

OFFICIAL INFORMATION

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PERMANENT COMMISSION

OF THE

International Railway Congress Association.

ENLARGED MEETING OF THE PERMANENT COMMISSION (Lisbon, 1949).

LIST OF QUESTIONS

for discussion

WITH THE NAMES OF THE REPORTERS.

1st SECTION : WAY AND WORKS.

QUESTION I.

a) **Mechanisation of the maintenance and renewal of the permanent way.**

b) **Recent improvements relating to reinforced concrete and prestressed concrete sleepers.**

Results obtained.

c) **Recovery and strengthening of metal bridges that have reached the theoretical limit of safety.**

Reporters :

English speaking countries :

Mr. V.A.M. ROBERTSON, Chief Civil Engineer, British Railways, Southern Region; Waterloo Station, London, S. E. 1.

Other countries :

M. L. MUCHERIE,* ingénieur en chef, chef de la Division de l'Entretien du Service de la Voie et des Bâtiments, Région du Sud-Ouest, Société Nationale des Chemins de fer français; 1, Place Valhubert, Paris (13^e);

* Now retired and replaced by M. GONON.

M. GONON, ingénieur en chef, chef de la Division de l'Entretien du Service de la Voie et des Bâtiments, Région du Nord, Société Nationale des Chemins de fer français; 18, rue de Dunkerque, Paris (10e); and

M. CASSÉ, ingénieur à la Division des Ouvrages d'art de la Société Nationale des Chemins de fer français; 51, rue de Londres, Paris (8e).

Special Reporter :

M. l'ingénieur José Chedas BOGARIM, chef de répartition à la Direction Générale des Chemins de fer; Lisbonne.

2nd SECTION : LOCOMOTIVES AND ROLLING STOCK.

QUESTION II.

Electric locomotives for fast trains (75 m.p.h. and over).

Discussion of adopted and projected types.

1. **Arrangement of the axles.**
2. **Type of axle drive :**
   - **a) motor suspended from the nose;**
   - **b) flexible transmission.**
3. **Electric motor characteristics.**
4. **Braking.**

Reporters :

English speaking countries :

Mr. G.A. DALTON, Chief Electrical Engineer, South African Railways; Johannesburg (South Africa).

Other countries :

Dr. Ing. E. MEYER, ingénieur en chef adjoint de la Division de la Traction et des Ateliers des Chemins de fer fédéraux Suisses; Berne.

Special Reporter :

M. l'ingénieur Alfredo D'ARBELA, inspecteur en chef du Service du Matériel et de la Traction des Chemins de fer de l'Etat italien.

3rd SECTION : WORKING.

QUESTION III.

Transport of miscellaneous goods.

Concentration in a certain number of selected centres (stations) of miscellaneous traffic, transport by rail between centre-stations, by road or rail between the originating points and the nearest centre-station, and also to the last centre-station near the destination.

Interest of the scheme for the conveyance of goods traffic.

Organisation of the station-centres and of the collection and delivery services.

Financial results of the scheme.

Reporters :

English speaking countries :

Mr. P.H. SARMA, Director of Wagon Interchange and General Secretary of the Indian Railway Conference Association; New Delhi (India).

Other countries :

M. MOULART, ingénieur en chef au Service de l'Exploitation de la Société Nationale des Chemins de fer belges; 17, rue de Louvain, Bruxelles.

Special Reporter :

Dr. Joâo Faria LAPA, chef de la Division Commerciale de la Compagnie des Chemins de fer portugais; Lisbonne.